ICP/EXT-04-00209
Revision 1

Health and Safety Plan for the Accelerated Retrieval Project for a Described Area within Pit 4

Kelly Wooley

Idaho Completion Project

Bechtel BWXT Idaho, LLC

April 2004

ICP/EXT-04-00209
Revision 1
Project No. 23927

Health and Safety Plan for the Accelerated Retrieval Project for a Described Area within Pit 4

Kelly Wooley

April 2004

Idaho Completion Project
Idaho Falls, Idaho 83415

Prepared for the
U.S. Department of Energy
Assistant Secretary for Environmental Management
Under DOE/NE Idaho Operations Office
Contract DE-AC07-99ID13727

Health and Safety Plan for the Accelerated Retrieval Project for a Described Area within Pit 4

ICP/EXT-04-00209
Revision 1

Approved by

David L. Hall, Bechtel BWXT Idaho, LLC
Accelerated Retrieval Project Operations Manager

4/5/04
Date

David E. Wilkins, Bechtel BWXT Idaho, LLC
Accelerated Retrieval Project Manager

4/6/04
Date

ABSTRACT

This health and safety plan establishes the procedures and requirements used to eliminate or minimize health and safety risks to personnel performing construction and operational tasks within the Accelerated Retrieval Project area in the Subsurface Disposal Area of the Radioactive Waste Management Complex. The Accelerated Retrieval Project is part of the Idaho Completion Project at the Idaho National Engineering and Environmental Laboratory. This plan has been prepared to meet Occupational Safety and Health Administration standards.

This plan contains the assessment and associated mitigation of safety, health, and radiological hazards for conducting operational activities within the Accelerated Retrieval Project area. Safety, health, and radiological professionals assigned to support the Accelerated Retrieval Project will define the most appropriate hazard control and mitigation measures based on operations-specific conditions and will make changes to this plan and associated work control documents as appropriate.

CONTENTS

FIGURES

TABLES

ACRONYMS

ACGIH	American Conference of Government Industrial Hygienists
ALARA	as low as reasonably achievable
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
dBA	decibel A-weighted
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ERO	Emergency Response Organization
GFCI	ground-fault circuit interrupter
HASP	health and safety plan
HAZWOPER	hazardous waste operations and emergency response
HEPA	high-efficiency particulate air
HSO	health and safety officer
IARC	International Agency for Research on Cancer
IDLH	immediately dangerous to life or health
IH	industrial hygienist
INEEL	Idaho National Engineering and Environmental Laboratory
ISMS	Integrated Safety Management System
JSA	job safety analysis
LLW	low-level waste
MCP	management control procedure
MSDS	material safety data sheet
NFM	nuclear facility manager
NIOSH	National Institute of Occupational Safety and Health
NTP	National Toxicology Program

OMP	Occupational Medical Program
OSHA	Occupational Safety and Health Administration
PCM	personal contamination monitor
PEL	permissible exposure limit
PPE	personal protective equipment
PVC	polyvinyl chloride
RadCon	Radiological Control
RCIMS	Radiological Control and Information Management System
RCT	radiological control technician
RWMC	Radioactive Waste Management Complex
RWP	radiological work permit
SDA	Subsurface Disposal Area
STEL	short-term exposure limit
STR	subcontractor technical representative
SWP	safe work permit
TLD	thermoluminescent dosimeter
TLV	threshold limit value
TPR	technical procedure
TRU	transuranic
TWA	time-weighted average
UV	ultraviolet
VPP	Voluntary Protection Program
WCC	Warning Communications Center

Health and Safety Plan for the Accelerated Retrieval Project for a Described Area within Pit 4

1. WORK SCOPE

1.1 Purpose

This health and safety plan (HASP) identifies health and safety hazards and requirements used to eliminate or minimize hazards during Accelerated Retrieval Project construction and operations at the Radioactive Waste Management Complex (RWMC). The Accelerated Retrieval Project is part of the Idaho Completion Project at the Idaho National Engineering and Environmental Laboratory (INEEL). This HASP has been written to meet the requirements of the Occupational Safety and Health Administration (OSHA) standard, "Hazardous Waste Operations and Emergency Response" (29 CFR 1910.120; 29 CFR 1926.65).

This HASP will address Accelerated Retrieval Project construction and operational hazards and the associated mitigation. This HASP is applicable to all soil invasive construction and all operational activities at the Accelerated Retrieval Project site in the RWMC Subsurface Disposal Area (SDA), unless evaluated and documented as not applicable by the Accelerated Retrieval Project health and safety officer (HSO) based on actual field conditions. This plan and additional job safety analyses (JSAs), operational technical procedures (TPRs), project work orders, maintenance work orders, program requirements documents, and management control procedures (MCPs) will further define Accelerated Retrieval Project hazards, hazard mitigation, and procedural requirements as new hazards are identified as the facility begins construction and operation. This HASP will be reviewed and revised, as appropriate, by the Accelerated Retrieval Project HSO in consultation with Industrial Hygiene, Industrial Safety, and Radiological Control (RadCon) support personnel to ensure its effectiveness and suitability for Accelerated Retrieval Project activities.

1.2 Applicability and Jurisdiction

Project operations will be conducted under the administrative controls of a safety analysis. Technical procedures, JSAs, and other appropriate project health and safety evaluations will be conducted to ensure operations are in compliance with the facility authorization basis. Project operations will fall within the jurisdiction of the RWMC operations director. This HASP applies to all personnel conducting Accelerated Retrieval Project construction and operational activities in these areas.

1.3 Site Description of the Idaho National Engineering and Environmental Laboratory

The INEEL is a U.S. government-owned test site located 53 km (32 mi) west of Idaho Falls in southeastern Idaho (see Figure 1-1) and managed by the U.S. Department of Energy (DOE). The INEEL encompasses approximately 2,305 m^2 (890 mi^2) of the northeastern portion of the Eastern Idaho Snake River Plain. The Eastern Idaho Snake River Plain is a relatively flat, semiarid, sagebrush desert with predominant relief being manifested either as volcanic buttes jutting up from the desert floor or as unevenly surfaced basalt flows or flow vents and fissures. Elevations on the INEEL range from 2,003 m (6,572 ft) in the southeast to 1,448 m (4,750 ft) in the central lowlands, with an average elevation of 1,516 m (4,975 ft). Drainage within and around the plain recharges the Snake River Plain Aquifer, a sole-source aquifer that flows beneath the INEEL and surrounding area. The aquifer is approximately 137 m (450 ft) below ground surface within the Site boundaries. Regional groundwater flow is southwest at average estimated velocities of 1.5 m/day (5 ft/day).

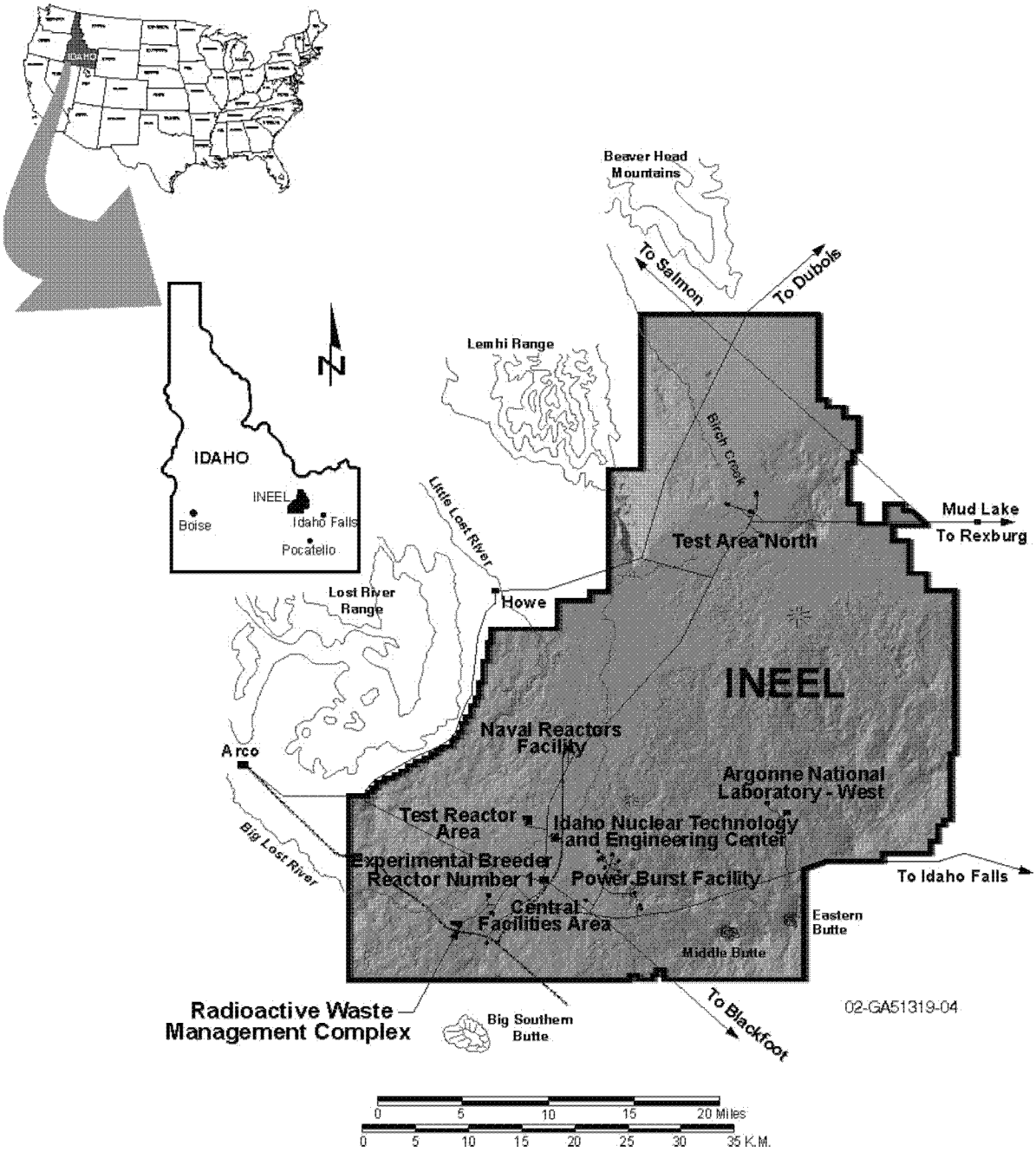

Figure 1-1. Map showing the location of the Radioactive Waste Management Complex at the Idaho National Engineering and Environmental Laboratory.

1.4 History of the Radioactive Waste Management Complex

The U.S. Atomic Energy Commission initially established the Site in 1949 as the National Reactor Testing Station for nuclear energy research and related activities. In 1952, the Site expanded its function and began accepting shipments of transuranic (TRU) radionuclides and radioactive low-level waste (LLW). In 1974, it was redesignated the Idaho National Engineering Laboratory, and then in 1997, to reflect the expansion of its mission to include a broader range of engineering and environmental management activities, the name was changed to INEEL. Currently, the INEEL is used to support the engineering efforts and operations of the DOE and other federal agencies in areas of nuclear safety research, reactor development, reactor operations and training, nuclear defense materials production, waste management technology development, and energy technology and conservation programs. The U.S. Department of Energy Idaho Operations Office has responsibility for the INEEL and delegates authority to operate the INEEL to government contractors. Bechtel BWXT Idaho, LLC, is the current management and operating contractor for the INEEL.

The RWMC was established in the early 1950s as a disposal site for solid LLW generated by operations at the INEEL and other DOE laboratories. Radioactive waste materials were buried in underground pits, trenches, soil vault rows, and one aboveground pad (Pad A) at the SDA. Transuranic waste is kept in interim storage in containers on asphalt pads at the Transuranic Storage Area. Radioactive waste from the INEEL was disposed of in the SDA starting in 1952. Rocky Flats Plant (RFP)[a] TRU waste was disposed of in the SDA from 1954 to 1970. Post-1970 TRU waste is kept in interim storage in containers on asphalt pads at the Transuranic Storage Area.

In August 1987, in accordance with the Resource Conservation and Recovery Act (42 USC § 6901 et seq., 1976), the DOE and the U.S. Environmental Protection Agency (EPA) entered into a *Consent Order and Compliance Agreement* (DOE-ID 1987). The *Consent Order and Compliance Agreement* required DOE to conduct an initial assessment and screening of all solid and hazardous waste disposal units at the INEEL and set up a process for conducting any necessary corrective actions. On July 14, 1989, the EPA (under the authority granted to them by the Comprehensive Environmental Response, Compensation and Liability Act [CERCLA] [42 USC § 9601 et seq., 1980], as amended by the Superfund Amendments and Reauthorization Act [Public Law 99-499, 1986]) proposed that the INEEL be listed on the National Priorities List (54 FR 29820, 1989). The final rule that listed the INEEL on the National Priorities List was published on November 21, 1989 (54 FR 48184, 1989). On December 4, 1991, because of the INEEL's listing on the National Priorities List, DOE, EPA, and the Idaho Department of Health and Welfare entered into the *Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory* (DOE-ID 1991). The Federal Facility Agreement and Consent Order established the procedural framework and schedule for developing, prioritizing, implementing, and monitoring response actions at the INEEL in accordance with CERCLA, Resource Conservation and Recovery Act, and the Idaho Hazardous Waste Management Act (Idaho Code § 39-4401 et seq., 1983).

1.5 Accelerated Retrieval Project Overview

Commitments of DOE to the State of Idaho and the EPA contain enforceable deadlines that require analyzing the need to remediate buried TRU waste at the INEEL. The TRU waste is a result of INEEL support for the nuclear energy mission of the United States, both as a research laboratory and a waste management facility.

---

a. The RFP, located 26 km (16 mi) northwest of Denver, Colorado, was renamed the Rocky Flats Environmental Technology Site in the mid-1990s. In the late 1990s, it was again renamed to its present name, the RFP Closure Project.

Waste buried at the SDA presents a potential risk to the Snake River Plain Aquifer from subsurface vapor-phase and aqueous transport of contaminants. For this reason, the U.S. Department of Energy Idaho Operations Office has elected to retrieve waste from selected high-density areas containing buried TRU waste under the CERCLA National Contingency Plan non-time-critical removal action process.

Retrieval and site remediation include removing the overburden soil originally placed over the waste material; excavating material from the waste zone; sampling that material to determine whether it contains contaminants of concern (COCs), such as volatile organic compounds; assaying the waste material to segregate it into TRU (greater than 100 nCi/g) and non-TRU (less than or equal to 100 nCi/g) waste; treating the non-TRU material to reduce COCs, if necessary; packaging the TRU material for shipment; and returning the non-TRU material to the excavated site.

1.5.1 Accelerated Retrieval Project Facilities

The Accelerated Retrieval Project uses a Retrieval Enclosure and airlock, a Storage Enclosure, and support facilities. These facilities are described in more detail in the following sections.

1.5.1.1 Accelerated Retrieval Project Retrieval Enclosure. The Retrieval Enclosure is a temporary structure that will house excavation, packaging, sampling, package decontamination, and personnel and equipment ingress and egress activities. The Retrieval Enclosure provides weather protection and year-round operations for these activities. The Retrieval Enclosure is a commercially available, standard, fabric-tensioned structure, approximately 51.8 m (170 ft) wide by 87.8 m (288 ft) long with a 6.1-m-minimum (20-ft-minimum) interior clearance at the eaves. An attached 21.3 × 15.2-m (70 × 50-ft) structure houses the airlock operations. It has sufficient space and interior height to house excavator operations and waste-container movements.

The Retrieval Enclosure is constructed of a prefabricated metal frame covered with an inner and outer polyvinyl chloride (PVC)-coated, polyester-fabric membrane. The fabric membranes meet "Standard Methods of Fire Tests for Flame Propagation of Textiles and Films" (NFPA 701) standards for fire resistance. The PVC and polyester have been shown to maintain their structural integrity when exposed to carbon tetrachloride concentrations of 1,000 ppm (EDF-2337). The structural frames will be designed to support snow and windloads in accordance with the loading requirements of the "DOE-ID Architectural Engineering Standards" (DOE-ID 2002) as well as the negative pressure loading imposed by the ventilation system. An anchoring system will be provided to resist the horizontal or uplift forces imposed by snow and windloads. The perimeter foundation frame will sit on the ground surface that has been leveled to obtain a perimeter seal. Mechanical and electrical equipment supporting the Retrieval Enclosure is housed external to the enclosure.

Ventilation is provided by a high-efficiency particulate air (HEPA)-filtered exhaust system. The exhaust stack is designed to minimize local worker exposure and permit proper radiological emissions monitoring configuration. The ventilation system is equipped with an emissions monitoring system to sample and record possible releases of radioactive substances.

A direct-fired heating system will be used to heat the Retrieval Enclosure. The direct-fired heaters minimize potential for propane to enter the facility because of the high burn efficiency of the units. The heater is equipped with a spark-ignited intermittent pilot and a single-stage, 24-V gas valve.

The Retrieval Enclosure will be provided with electricity for auxiliary equipment and small loads as required. Because of the mobile nature of the Retrieval Enclosure, extensive use will be made of flexible cords and cables as opposed to conductors in conduit. Lighting in the Retrieval Enclosure is both

fixed position and mobile for adjusting to the excavation process. Adequate fixed lighting will be positioned to permit operators to safely walk throughout the retrieval facility.

1.5.1.2 Retrieval Enclosure Airlock. The airlock provides a buffer area for workers to repackage waste, remotely observe excavation activities, and perform decontamination activities. The buffer area also provides for personal protective equipment (PPE) changeout. The airlock is designed to flow approximately six air changes per hour, with the flow going from outside the airlock, through HEPA filters mounted in the airlock structure walls, and into the Retrieval Enclosure. Electric radiant spot heaters provide localized heating, and air conditioning is provided to maintain adequate working temperatures in the airlock structure.

1.5.1.3 Storage Enclosure. The Storage Enclosure is a temporary structure that provides indoor storage and staging of packaged waste. The Storage Enclosure is a commercially available, standard, fabric-tensioned structure, approximately 39.6 m (130 ft) wide by 48.8 m (160 ft) long with 6.1-m-minimum (20-ft-minimum) interior clearance at the eaves. The Storage Enclosure is constructed of a prefabricated metal frame covered with an outer PVC-coated polyester fabric membrane. The structural frames are designed to support snow and windloads in accordance with the loading requirements of the "DOE-ID Architectural Engineering Standards" (DOE-ID 2002). The Storage Enclosure has an anchoring system designed to resist the horizontal or uplift forces imposed by snow and windloads. The interior floor consists of a compacted, crushed gravel bed. Mechanical and electrical equipment supporting the Storage Enclosure is housed external to the enclosures. The Storage Enclosure is not heated but may be ventiled to minimize accumulation of volatile organic compounds, if required.

1.5.1.4 Operational Support Facilities. Operational support facilities include a mobile fissile material assay unit(s), breathing air unit(s), mobile sample support unit, and operations support trailers. The support facilities will be used as required to support operations, including providing a general work area, a viewing area with monitors for visual observation, minimal lab capabilities, PPE changeout, storage, and utility housings. These facilities will be positioned near the Retrieval Enclosure and used by operations to support the activities performed onsite in the SDA and within the Retrieval Enclosure.

1.5.2 Accelerated Retrieval Project Construction

The Accelerated Retrieval Project construction activities include site development and utilities work, retrieval enclosure and airlock installation, and Storage Enclosure installation. The operational support facilities will be installed during the construction phase as determined appropriate by project and construction management.

1.5.2.1 Site Development and Utilities. The Accelerated Retrieval Project location is prepared during this phase for future construction and operational activities of the Accelerated Retrieval Project. The site development work includes the removal of overburden in the area of the Retrieval Enclosure. The overburden is removed and staged in a designated area of the SDA for later possible return to the pit. The site utilities, building pads, power, communications lines, and other support utilities are prepared or installed during this phase of work.

1.5.2.2 Retrieval Enclosure and Airlock Installation. The Retrieval Enclosure and airlock structure will be installed in the selected project area over Pit 4 where the overburden was previously removed. Retrieval Enclosure construction includes installation and securing of the prefabricated metal frame and covering the frame with the fabric membrane. The airlock structure is constructed to abut with the Retrieval Enclosure. All government-furnished equipment, power, and communication equipment is installed or connected.

1.5.2.3 Storage Enclosure. The Storage Enclosure will be installed and all support connections completed for operation. The Storage Enclosure will be constructed on a compacted, crushed gravel pad. The mechanical and electrical equipment supporting the Storage Enclosure is located next to the Storage Enclosure facility.

1.5.3 Accelerated Retrieval Project Operations

The Accelerated Retrieval Project provides a cost-effective method of retrieving and managing SDA waste material, while maintaining protection of the workers, public health, and the environment. The basic concept comprises waste retrieval in the Retrieval Enclosure, transfer of waste containers into the airlock for processing, assay of the waste containers after release from the airlock, and interim storage in a Storage Enclosure in the SDA. Other processes necessary for the safe handling and processing of the waste and waste containers will be performed as determined necessary by the project. The following section describes the process in greater detail.

1.5.3.1 Accelerated Retrieval Project Waste Retrieval and Handling Operations. Operators in PPE will operate two Gradall XL-5200 excavators to retrieve and package material from a described area within Pit 4 (see Figure 1-2) into waste containers. The excavator and forklift cabs will be provided with a blower/HEPA-filtered, forced-air system to provide additional protection for the operator. Personnel access to the Retrieval Enclosure will be limited during excavation activities, but there may be other individuals in PPE allowed inside, such as radiological control technicians (RCTs).

The waste-zone material will be retrieved using the excavators. The excavator will operate above grade. The pit is expected to be approximately 6.1–8.5 m (20–28 ft) deep, and the walls will be sloped to maintain an angle of repose of approximately one to one.

At the digface, excavators will retrieve targeted waste (e.g., graphites, filters, Series 741 and 743 sludge, and uranium) and place the waste in a tray with a plastic liner. The targeted/nontargeted determination will be made by an operator assisting the excavator operator by way of closed-circuit television cameras at the digface and mounted on the excavator. Nontargeted waste (e.g., debris, soil, and Series 742 and 744 sludge) will be returned to the excavation. The trays of targeted waste will be transported to a drum-out area by forklift.

At the drum loadout area, operators will assign a Waste Isolation Pilot Plant summary category group number to the tray of waste, sample as necessary, and remove any prohibited items if obvious. The plastic tray will then be hoisted and loaded into a drum. The drum will be counted using a fissile material monitor, if the waste contains graphites of filters, for criticality safety. The drum will then be removed from the area and transported to a fissile material assay system to ensure safe storage and eventually placed in the Storage Enclosure. This area also could accommodate waste boxes, if necessary.

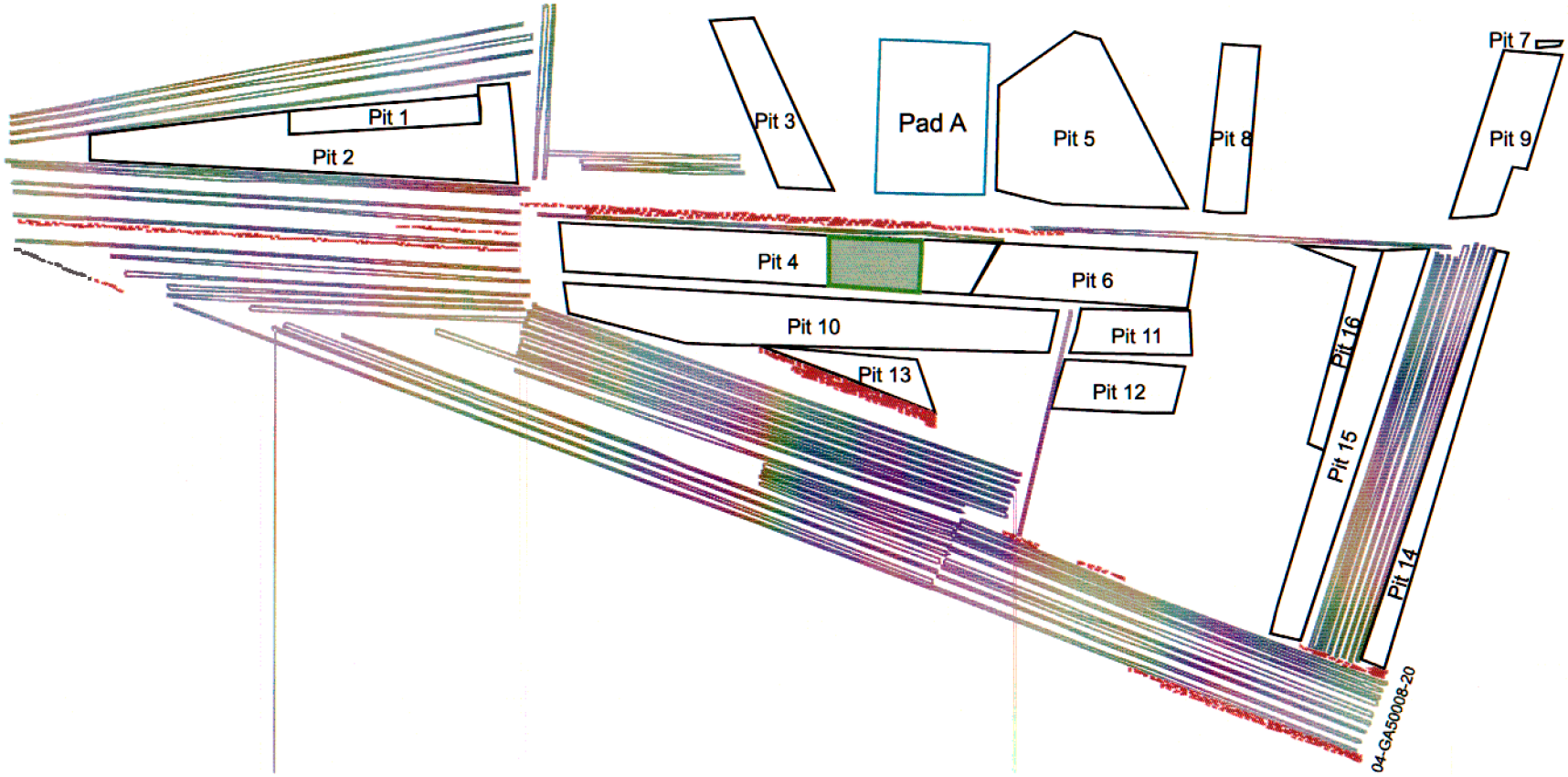

Figure 1-2. Map showing the described area within Pit 4 for the Accelerated Retrieval Project.

Before being placed in storage in the Storage Enclosure, each waste container will be assayed to verify fissile gram loading and distinguish between TRU (greater than 100 nCi/g) and non-TRU material. The TRU and non-TRU material will follow different treatment and disposition paths. Non-TRU material that contains hazardous COCs will be stored pending final disposition. The TRU material will be characterized, certified, treated for volatile organic compounds if necessary, and staged for final disposal. Waste may be temporarily stored outdoors in lag storage while waiting to be assayed. Transportation of waste containers will be performed by forklift or flatbed truck.

2. HAZARD IDENTIFICATION AND MITIGATION

Construction and operation of the Accelerated Retrieval Project facilities will present physical, chemical, and radiological hazards to personnel. Identification and mitigation of these hazards is imperative to prevent injury or exposure to personnel conducting these activities. The primary objective of this section is to identify existing and anticipated hazards based on project operations and to provide controls to eliminate or mitigate these hazards, which include the following:

- Evaluation of project operations to determine the extent that potential industrial safety, radiological, nonradiological, and physical hazards may affect facility personnel
- Establishment of the necessary monitoring and sampling required to evaluate exposure and contamination levels, determine action levels to prevent exposures, and provide specific actions to be followed if action levels are reached
- Determination of necessary engineering controls, isolation methods, administrative controls, work practices, and (where these measures will not adequately control hazards) PPE to further protect project personnel from hazards.

The purpose of this hazard identification section is to lead the user to an understanding of the occupational safety and health hazards associated with project operational tasks. This will enable project management and safety and health professionals to make effective and efficient decisions related to the equipment, processes, procedures, and the allocation of resources to protect the safety and health of project personnel.

The magnitude of danger presented by the project hazards to personnel conducting project operations in the Retrieval Enclosure is dependent on both the nature of tasks being performed and the proximity of personnel to the hazardous materials and operations. Engineering controls have been implemented along with administrative controls, work procedures, and PPE to further mitigate potential exposures and hazards.

The following section describes the chemical, radiological, safety, and environmental hazards that personnel may encounter while conducting project operational activities. Hazard mitigation will be accomplished through a combination of designed engineering controls with other work controls (e.g., TPRs, work orders, JSAs, safe work permits [SWPs], and radiological work permits [RWPs]). This hazard mitigation strategy will be used to eliminate or mitigate project hazards in accordance with "Activity Level Hazard Identification, Analysis, and Control" (PRD-25) to the extent possible.

2.1 Chemical and Radiological Hazards and Mitigation

Personnel may be exposed to industrial safety hazards or to radiological, nonradiological, and physical agents while conducting project operations. Designed engineering controls will be implemented along with work procedures, real-time monitoring of contaminants, and project facility-specific hazard training to further mitigate potential hazards and exposures. Formal preplanning (e.g., job walk-down, completion of the hazard profile screening checklists, and prejob briefing checklists), JSAs, and other work controls will be written based on the hazards identified in this HASP, TPRs, "Integrated Work Control Process" (STD-101), work packages, and operational conditions. These documents will specify specific operational hazard mitigation measures to follow.

2.1.1 Radiological Material Inventory

The radioactive material inventory in the SDA is discussed in a draft version of "Preliminary Safety Analysis Report for the Accelerated Retrieval Project for a Described Area within Pit 4"[a] and a final version of "SDA Inventory Evaluation for ISG, ISV, and ISTD PDSA Source Terms" (EDF-3543). Some uncertainties about the radioactive material inventory exist. Therefore, several sources of information were used in the engineering design file to determine the most conservative average and bounding inventories. These include an evaluation of shipping records, nondestructive examination data on aboveground waste, inventory database evaluation, SDA probe data, and sample data at the RFP. The uncertainty in waste shipping records, process knowledge, and calculation methods precludes determining exact quantities; however, these estimates are the result of careful analysis and the best professional judgment.

Rather than develop SDA pit or trench specific inventories, the engineering design file develops representative radioactive and nonradioactive material inventories per drum and areal-drum densities at the SDA. The engineering design file addresses all waste types buried in the SDA, including TRU waste, contact-handled LLW, and remote-handled LLW. It also addresses nonradioactive hazardous materials that are part of the mixed TRU and LLW waste. The areas analyzed include the closed pits (Pits 1–16), the open pits (Pits 17–20), all trenches (Trenches 1–58), and all soil vault rows (Rows 1–21). While the engineering design file addresses areas of the SDA that will not be excavated, it represents bounding inventories for the project.

Using the methodology of "SDA Inventory Evaluation for ISG, ISV, and ISTD PDSA Source Terms" (EDF-3543) for determining large-area TRU inventories, the inventory for the Accelerated Retrieval Project is estimated to be approximately 23,197.9 Ci of Pu-239 equivalents. This inventory includes trench data but is considered representative of the SDA pits. The excavation area is assumed to be 33.5 × 61.6 m (6772.7 m^2) (110 × 202 ft [22,220 ft^2]). The estimated TRU inventory is derived in Table 2-1.

Table 2-1. Estimated transuranic inventories for the Accelerated Retrieval Project.

Estimated transuranic inventory	=	Impacted area × median transuranic drum areal density × average drum content = 22,220 ft^2 × 0.29 drums/ft^2 × 3.6 Ci/drum = 23,197.9 Ci of Pu-239 equivalents

The "SDA Inventory Evaluation for ISG, ISV, and ISTD PDSA Source Terms" (EDF-3543) also provides a methodology for determining large-area LLW inventories in the SDA. The estimated LLW inventories for significant LLW isotopes (based on inventory and inhalation hazard) are provided in Table 2-2. The majority of these inventories are found in the SDA trenches but are considered bounding for the project.

a. SAR-215, 2004, "Preliminary Safety Analysis Report for the Accelerated Retrieval Project for a Described Area within Pit 4," Rev. 0B, Idaho National Engineering and Environmental Laboratory.

Table 2-2. Estimated low-level waste inventory in excavation area.

Isotope	Best Estimate Average Inventory (Ci/ft^2)	Affected Area (ft^2)	Average Inventory for Excavation (Ci)
Co-60	1.80E+00	22,220	4.00E+04
Fe-55	3.30E+00	22,220	7.33E+04
Cr-51	6.40E–01	22,220	1.42E+04
H-3	1.20E+00	22,220	2.67E+04
Ni-63	1.10E+00	22,220	2.44E+04
Co-58	3.00E–01	22,220	6.67E+03
Mn-54	2.50E–01	22,220	5.56E+03
Sr-90	5.30E–01	22,220	1.18E+04
Cs-137	5.10E–01	22,220	1.13E+04
Ce-144	1.20E–01	22,220	2.67E+03

2.1.2 Nonradiological Inventory

The chemical inventory in the SDA is developed in "SDA Inventory Evaluation for ISG, ISV, and ISTD PDSA Source Terms" (EDF-3543) and summarized in a draft version of "Preliminary Safety Analysis Report for the Accelerated Retrieval Project for a Described Area within Pit 4" (see Footnote a). The engineering design file also provides a methodology that can be used to determine the chemical inventory for this project. While the engineering design file addresses areas of the SDA that will not be excavated as part of this project, it represents bounding inventories for the project. The uncertainty in waste shipping records, process knowledge, and calculation methods precludes determining exact quantities; however, these estimates are the result of careful analysis and the best professional judgment. The SDA nonradiological hazardous inventory and the project inventory for a 33.5 × 61.6-m (110 × 202-ft) excavation are estimated in Table 2-3.

There are a number of nonradioactive hazardous materials in the SDA that are present in trace amounts, of which presence or location cannot be verified or of which quantities are unknown. These materials include picric acid, at least two 25-lb packs of sodium or potassium cyanide, lithium oxide from RFP battery waste, nitrobenzene, and polychlorinated biphenyls (Einerson and Thomas 1999).

Nitrocellulose is a fire and explosion hazard. An analysis has been performed on the likelihood of explosive quantities of nitrocellulose present in the SDA and the likelihood of nitrocellulose formation in the SDA. This analysis concluded that the likelihood of a nitrocellulose explosion or the formation of nitrocellulose in the SDA is highly improbable.

Table 2-3. Nonradiological hazardous materials inventory for Subsurface Disposal Area and estimated for the Accelerated Retrieval Project excavation size.

Chemical	Chemical Abstract System #	Average Subsurface Disposal Area Density (g/ft^2)	Excavation Area (ft^2)	Average Inventory (g)
1,1,1-trichloroethane	71-55-6	1.70E+02	22,220	3.78E+06
1,1,2-trichloro-1,2,2-trifluoroethane	76-13-1	1.30E+01	22,220	2.89E+05
2-butanone	78-93-3	5.60E–02	22,220	1.24E+03
Acetone	67-64-1	1.80E–01	22,220	4.00E+03
Aluminum nitrate nonahydrate	7784-27-2	3.40E+02	22,220	7.55E+06
Ammonia	7664-41-7	2.50E+00	22,220	5.56E+04
Anthracene	120-12-7	6.50E–04	22,220	1.44E+01
Antimony	7440-36-0	1.40E–03	22,220	3.11E+01
Aqua regia	NA	4.50E–05	22,220	1.00E+00
Arsenic	7440-38-2	1.60E–06	22,220	3.56E–02
Asbestos	1332-21-4	6.70E+00	22,220	1.49E+05
Barium	7440-39-3	1.70E–05	22,220	3.78E–01
Benzine	8032-32-4	6.70E–03	22,220	1.49E+02
Beryllium	7440-41-7	1.00E+02	22,220	2.22E+06
Butyl alcohol	71-36-3	1.50E–01	22,220	3.33E+03
Cadmium	7440-43-9	3.20E+00	22,220	7.11E+04
Carbon tetrachloride	56-23-5	1.20E+03	22,220	2.67E+07
Cerium chloride	7790-86-5	8.70E–01	22,220	1.93E+04
Chloroform	67-66-3	5.20E–05	22,220	1.16E+00
Chromium	7440-47-3	2.20E–03	22,220	4.89E+01
Copper	7440-50-8	6.30E–02	22,220	1.40E+03
Copper nitrate	3251-23-8	5.80E–04	22,220	1.29E+01
Ethyl alcohol	64-17-5	3.90E–02	22,220	8.67E+02
Formaldehyde	50-00-0	2.10E–01	22,220	4.67E+03
Hydrazine	302-01-2	3.20E–03	22,220	7.11E+01
Hydrofluoric acid	7664-39-3	1.30E+01	22,220	2.89E+05
Lead	7439-92-1	1.10E+03	22,220	2.44E+07
Magnesium	7439-95-4	1.50E+01	22,220	3.33E+05
Magnesium fluoride	7783-40-6	2.00E–01	22,220	4.44E+03
Mercury	7439-97-6	2.70E+00	22,220	6.00E+04
Mercury nitrate monohydrate	10045-94-0	1.40E+00	22,220	3.11E+04
Methyl alcohol	67-56-1	3.50E–01	22,220	7.78E+03
Methyl isobutyl ketone	108-10-1	1.50E+01	22,220	3.33E+05

Table 2-3. (continued).

Chemical	Chemical Abstract System #	Average Subsurface Disposal Area Density (g/ft^2)	Excavation Area (ft^2)	Average Inventory (g)
Methylene chloride	75-09-2	2.10E+01	22,220	4.67E+05
Nickel	7440-02-0	5.80E–03	22,220	1.29E+02
Nitric acid	7697-37-2	8.60E+01	22,220	1.91E+06
Potassium chloride	7447-40-7	1.30E+02	22,220	2.89E+06
Potassium cyanide	151-50-8	2.70E–03	22,220	6.00E+01
Potassium dichromate	7778-50-9	4.20E+00	22,220	9.33E+04
Potassium nitrate	7757-79-1	3.40E+03	22,220	7.55E+07
Potassium phosphate	7778-77-0	1.80E+01	22,220	4.00E+05
Potassium sulfate	7778-80-5	1.30E+02	22,220	2.89E+06
Silver	7440-22-4	1.00E–02	22,220	2.22E+02
Sodium	7440-23-5	1.10E–01	22,220	2.44E+03
Sodium chloride	7647-14-5	2.50E+02	22,220	5.56E+06
Sodium cyanide	143-33-9	2.70E–03	22,220	6.00E+01
Sodium dichromate	0588-01-9	7.60E+00	22,220	1.69E+05
Sodium hydroxide	1310-73-2	4.80E–04	22,220	1.07E+01
Sodium nitrate	7631-99-4	6.50E+03	22,220	1.44E+08
Sodium phosphate	10101-89-0	3.80E+01	22,220	8.44E+05
Sodium potassium	11135-81-2	3.20E+00	22,220	7.11E+04
Sodium sulfate	7757-82-6	2.90E+02	22,220	6.44E+06
Sulfuric acid	7664-93-9	2.10E–01	22,220	4.67E+03
Terphenyl	26140-60-3	1.40E+00	22,220	3.11E+04
Tetrachloroethylene	127-18-4	1.40E+02	22,220	3.11E+06
Toluene	108-88-3	3.50E–01	22,220	7.78E+03
Tributyl phosphate	126-73-8	1.80E+00	22,220	4.00E+04
Trichloroethylene	79-01-6	1.70E+02	22,220	3.78E+06
Trimethylolpropane-triester	15625-89-5	2.20E+00	22,220	4.89E+04
Uranium	NA	7.60E+02	22,220	1.69E+07
Uranyl nitrate	36478-76-9	3.90E–01	22,220	8.67E+03
Versenes (EDTA)	NA	3.10E+01	22,220	6.89E+05
Xylene	1330-20-7	1.40E+00	22,220	3.11E+04
Zirconium	7440-67-7	3.20E+01	22,220	7.11E+05
Zirconium alloys	NA	1.00E+01	22,220	2.22E+05
Zirconium oxide	NA	7.40E–03	22,220	1.64E+02

NA = not assigned

2.1.3 Routes of Exposure

Exposure pathways exist for radiological and nonradiological contaminants that will be encountered during project operations. Engineering controls, monitoring, training, and work controls will mitigate potential contact and uptake of these hazards to a large extent; however, the potential for exposure still exists. The following list includes exposure pathways:

- **Inhalation** of radiological and nonradiological contaminated soil or fugitive dust during overburden excavation, waste handling and sorting, packaging, or decontamination tasks. Inhalable or respirable (dependent on the particle aerodynamic diameter) fugitive dust may have trace amounts of radiological or nonradiological contaminants associated with it, resulting in potential respiratory tract deposition.

- **Skin absorption and contact** with radiological and nonradiological contaminated soil or surfaces during overburden excavation, waste handling and sorting, packaging, decontamination, or system maintenance tasks. Radiological and nonradiological contaminants can be absorbed through broken skin or by solvent action, resulting in uptake, and skin contamination or irritation.

- **Ingestion** of radiological and nonradiological contaminated soil or materials adsorbed to fugitive dust particles or waste residues, resulting in potential uptake of contaminants into the upper respiratory tract or directly through the gastrointestinal tract (placing contaminated surfaces in mouth) that may result in gastrointestinal irritation, internal tissue irradiation, or deposition to target organs.

- **Injection** of radiological and nonradiological contaminated materials by breaking of the skin or migration through an existing wound, resulting in localized irritation, contamination, uptake of soluble contaminants, and deposition of insoluble contaminants.

An evaluation of the chemicals, the warning signs and symptoms of exposure, and exposure limits for each agent that may be potentially encountered in the SDA is provided in Table 2-4. Chemical and radiological hazards will be eliminated, isolated, or mitigated to the extent possible during all project construction and operations. Where these hazards cannot be eliminated or isolated through engineering controls, monitoring for chemical and radiological hazards will be conducted (as described in Section 3) to detect and quantify exposures. Additionally, administrative controls, training, work procedures, and protective equipment will be used to further reduce the likelihood of exposure to these hazards through the routes of entry listed above. Table 2-5 summarizes each primary construction and operational activity, associated hazards, and mitigation procedures.

The RWPs, JSAs, TPRs, and work orders will be used, and SWPs may be used in conjunction with this HASP to provide task- or activity-specific requirements for project activities. When used, these permits will further detail specialized PPE and dosimetry requirements.

Table 2-4. Evaluation of chemicals and potential agents that may be encountered.

Material or Chemical (Chemical Abstract Service Number, Vapor Density, and Ionization Energy)	Exposure Limit (PEL/TLV)	Routes of Exposure	Indicators or Symptoms of Overexposure (Acute and Chronic)	Target Organs and System	Carcinogen? (source)
Acetone (67-64-1)	TWA: 500 ppm STEL: 750 ppm.	Ih, Ig, Con	Irritation to eyes, nose, and throat; headache; dizziness; dermatitis; central nervous system depression	Eyes, skin, respiratory system, central nervous system	Yes – A4 – ACGIH
Ammonia (7664-41-7)	TWA: 25 ppm STEL: 35 ppm.	Ih, Ig, Con	Irritation to eyes, nose, and throat; despondent; bronchial spasms; chest pain; pulmonary edema; pink/frothy sputum; skin burns	Eyes, skin, respiratory system	No
Anthracene (120-12-7)	TWA: 0.2 mg/m^3.	Ih, Con	Dermatitis, bronchitis	Respiratory system, eyes, skin, bladder, kidneys	Yes – A1 – ACGIH
Antimony (7440-36-0)	TWA: 0.5 mg/m^3.	Ih, Ig, Con	Irritation to eyes, nose, mouth, and throat; cough; headache; nausea; diarrhea; stomach ache; insomnia; anorexia; unable to smell correctly; dizziness	Eyes, skin, respiratory system, cardiovascular system	No
Arsenic (inorganic compounds, as As) (7440-38-2)	TWA: 0.01 mg/m^3.	Ih, Abs, Con, Ig	Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, respiratory irritation, hyperpigmentation	Liver, kidneys, skin, lungs, lymphatic system	Yes – A1 – ACGIH
Ascorbic acid (50-81-7)	None established.	Ih, Ig	Eye irritation	Mild irritation of eyes only	No
Barium (7440-39-3)	TWA: 0.5 mg/m^3.	Ih, Ig, Con	Irritation of eyes, mucous, and skin; muscle and gastrointestinal cramps	Skin, eyes	Yes – A4 – ACGIH
Benzine (8032-32-4)	TWA: 350 mg/m^3 Ceiling: 1,800 mg/m^3.	Ih, Ig, Con	Irritation of eyes, upper respiratory system, dermatitis, central nervous system depression, chemical pneumonia	Eyes, skin, respiratory system, central nervous system	No

Table 2-4. (continued).

Material or Chemical (Chemical Abstract Service Number, Vapor Density, and Ionization Energy)	Exposure Limit (PEL/TLV)	Routes of Exposure	Indicators or Symptoms of Overexposure (Acute and Chronic)	Target Organs and System	Carcinogen? (source)
2-butanone (78-93-3)	TLV: 200 ppm STEL: 300 ppm.	Ih, Ig, Con	Eye irritation, skin irritation, nose irritation, headache, dizziness, vomiting, dermatitis	Eyes, skin, respiratory system, central nervous system	No
Butyl alcohol (75-65-0) VD = 2.55 IE = 9.7 eV	TLV: 20 ppm.	Ih, Ig, Con	Irritation of eyes, skin, nose, and throat; drowsiness; narcosis	Eyes, skin, respiratory system, central nervous system	No
Carbon tetrachloride (56-23-5) VD = 5.3 IE-=11.5 eV	TLV: 5 ppm STEL: 10 ppm Ceiling: 25 ppm.	Ih, Ig, Con	Irritation of eyes and skin, central nervous system depression, nausea, vomiting, liver, kidney injury, drowsiness, dizziness, uncoordination, (potential occupational carcinogen)	Central nervous system, eyes, lungs, liver, kidneys, skin	Yes – NIOSH – A2 – ACGIH
Chloroform (67-66-3) VD = 4.12 IE = 11.4 eV	TLV: 10 ppm.	Ih, Ig, Con	Irritation of eyes and skin, dizziness, mental dullness, nausea, confusion, headache, lassitude (weakness, exhaustion), anesthesia, enlarged liver, (potential occupational carcinogen)	Liver, kidneys, heart, eyes, skin, central nervous system	No
Chromium (as Cr) (7440-47-3)	TLV: CrIII: 0.5 mg/m^3 CrIV: 0.05 mg/m^3 CrVI: 0.01 mg/m^3.	Ih, Ig, Con	Irritation of eyes, sensitization, dermatitis	Eyes, skin	Yes – A4 and A1 – ACGIH
Copper (dust) (7440-50-8)	TLV: 0.1 mg/m^3.	Ih, Ig, Con	Irritation of eyes, upper respiratory system, metal fume fever, chills, muscle ache, nausea, fever, dry throat, cough, weakness, metallic taste, discoloration of skin and hair	Eyes, skin, respiratory system, liver, kidneys	No
Diesel fuel (68476-34-6) VD = 1.0 IE = N/A	TLV: 100 mg/m^3 (ACGIH—diesel fuel vapor or aerosol).	Ih, Ig, Con	Eye irritation, respiratory system changes, dermatitis	Eye, respiratory system	No

Table 2-4. (continued).

Material or Chemical (Chemical Abstract Service Number, Vapor Density, and Ionization Energy)	Exposure Limit (PEL/TLV)	Routes of Exposure	Indicators or Symptoms of Overexposure (Acute and Chronic)	Target Organs and System	Carcinogen? (source)
Diesel exhaust (particulate aerodynamic diameter <1 μm)	TLV: 0.02 mg/m^3 (ACGIH 2002).	Ih	Respiratory, nose, throat, or lung irritation with stinging and redness of the eyes; headache; nausea; dizziness; unconsciousness	Respiratory system	A2 – ACGIH
EDTA (tetrasodium) (64-02-8)	None established.	Ig, Con	Eye, skin, and mucous membrane irritation	Eyes, skin	No
Ethyl alcohol (64-17-5) VD = 1.6 IE = 10.47 eV	TLV: 1,000 ppm.	Ih, Ig, Con	Irritation of eyes, skin, and nose; headache; drowsiness; fatigue; narcosis; cough; liver damage; anemia; reproductive, teratogenic effects	Eyes, skin, respiratory system, central nervous system, liver, blood, reproductive system	No
Formaldehyde (50-00-0)	TWA: 0.75 ppm Ceiling: 0.3 ppm.	Ih, Con	Irritation of eyes, nose, throat, and respiratory system; cough bronchial spasms	Eyes, respiratory system	Yes – A2 – ACGIH
Freon 113 (76-13-1) VD = 2.9 IE = 11.99 eV	TLV: 1,000 ppm STEL: 1,250 ppm.	Ih, Ig, Con	Irritation of skin and throat; drowsiness; dermatitis; central nervous system depressant and depression (in animals); cardiac arrhythmia; narcosis	Skin, heart, central nervous system, cardiovascular system	No
Hydrazine (302-01-2)	TLV: 0.01 ppm.	Ih, Ig, Con, Abs	Irritation of skin, eyes, nose, and throat; temporary blindness; dizziness; nausea; dermatitis; burns	Eyes, skin, respiratory system, central nervous system, liver, kidneys	Yes – A3 – ACGIH
Hydroflouric Acid (7664-39-3)	TLV: 3 ppm Ceiling: 3 ppm.	Ih, Abs, Ig, Con	Irritation of skin, eyes, nose, and throat; pulmonary edema; burns; rhinitis; bronchitis; bone changes	Eyes, skin, respiratory system, bones	No
Methyl alcohol (67-56-1) VD = 1.11 IE = 10.84 eV	TLV: 200 ppm.	Ih, Ig, Con	Eye, skin, nose, and throat irritation; headache; drowsiness; optic nerve atrophy; chest tightness; narcosis	Eyes, skin, respiratory system, central nervous system	No
Methyl isobutyl ketone (108-10-1)	TLV: 50 ppm STEL: 75 ppm.	Ih, Ig, Con	Irritation of eyes, skin, and mucous membranes; headache; narcosis; coma; dermatitis	Eyes, skin, respiratory system, central nervous system, liver, kidneys	No

Table 2-4. (continued).

Material or Chemical (Chemical Abstract Service Number, Vapor Density, and Ionization Energy)	Exposure Limit (PEL/TLV)	Routes of Exposure	Indicators or Symptoms of Overexposure (Acute and Chronic)	Target Organs and System	Carcinogen? (source)
Methylene chloride (75-09-2) VD = 2.9 IE = 11.3 eV	TLV: 50 ppm OSHA (29 CFR 1910.1052). PEL: 25 ppm. STEL: 125 ppm.	Ih, Ig, Con	Eye and skin irritation, fatigue, weakness, somnolence, lightheadedness, numbness, tingle limbs, nausea	Eyes, skin, cardiovascular system, central nervous system	Yes – NIOSH – A3 – ACGIH
Nickel (elemental) (7440-02-0)	TLV: 1.5 mg/m^3.	Ih, Ig, Con	Sensitization dermatitis, allergic asthma, pneuitis	Nasal cavity, lungs, skin	Yes – A5 – ACGIH
Nitric acid (7697-37-2)	TLV: 2 ppm STEL: 4 ppm.	Ig, Con	Irritation of eyes, skin, and mucous membrane; pulmonary edema; pneuitis; bronchitis; dental erosion	Eyes, skin, respiratory system, teeth	No
Polychlorinated biphenyls not specified (Aroclor-1254 used for toxicological evaluation purposes)	TLV: 0.5 mg/m^3—skin.	Ih, Ig, Con	Eye irritation, chloracne, liver damage, reproductive effects	Skin, eyes, liver, reproductive system	Yes – NTP Yes – IARC No – OSHA
Sodium hydroxide (1310-73-2)	Ceiling: 2 mg/m^3.	Ih, Ig, Con	Irritation of eyes, skin, and mucous membranes; pneuitis; burns; hair loss	Eyes, skin, respiratory system	No
Sulfuric acid (7664-93-9)	TWA: 1 mg/m^3.	Ih, Ig, Con	Irritation of eyes, skin, nose, and throat; pulmonary edema; bronchitis; emphysema; stomatis; dental erosion; tracheal bronchitis; burns; dermatitis	Eyes, skin, respiratory system, teeth	No
Tetrachloroethene (127-18-4) VD = 5.8 IE = 9.3 eV	TLV: 25 ppm STEL: 100 ppm.	Ih, Ig, Con	Eye, skin, nose, throat, and respiratory system irritation; nausea; flush face or neck; vertigo; dizziness; uncoordination; headache; somnolence; skin erythema; liver damage	Eyes, skin, respiratory system, liver, kidneys, central nervous system	Yes – NIOSH

Table 2-4. (continued).

Material or Chemical (Chemical Abstract Service Number, Vapor Density, and Ionization Energy)	Exposure Limit (PEL/TLV)	Routes of Exposure	Indicators or Symptoms of Overexposure (Acute and Chronic)	Target Organs and System	Carcinogen? (source)
1,1,1-trichloroethane (71-55-6) VD = 4.6 IE = 11.1 eV	TLV: 350 ppm STEL: 450 ppm.	Ih, Ig, Con	Eye and skin irritation; headache; lassitude; central nervous system depressant or depression; poor equilibrium; dermatitis; cardiac arrhythmias; liver damage	Eyes, skin, central nervous system, cardiovascular system, liver	No – A4 – ACGIH
Trichloroethene (79-01-6) VD = 4.53 IE = 9.5 eV	TLV: 50 ppm STEL: 100 ppm.	Ih, Ig, Con	Eye and skin irritation; headache; vertigo; visual disturbance; fatigue; giddiness; tremor; somnolence; nausea; vomiting; dermatitis; cardiac arrhythmias; paresthesia; liver injury	Eyes, skin, respiratory system, heart, liver, kidneys, central nervous system	Yes – NIOSH
Toluene (108-88-3)	TLV: 50 ppm.	Ih, Ig, Abs, Con	Irritation of eyes and nose; fatigue; weakness; dizziness; headache; dilated pupils; muscle fatigue; insomnia; paresthesia; liver or kidney damage	Eyes, skin, respiratory system, central nervous system, kidneys, liver	Yes – A4 – ACGIH
Tributyl phosphate (126-73-8)	TLV: 0.2 ppm.	Ih, Ig, Con	Irritation of eyes, skin, and respiratory system; headache; nausea	Eyes, skin, respiratory system	No
Uranium (insoluble U) (7440-61-1)	TLV: 0.2 mg/m^3 STEL: 0.6 mg/m^3.	Ih, Ig, Con	Dermatitis, kidney damage, blood changes	Skin, eyes, bone marrow, lymphatic system	Yes – A1 – ACGIH
Xylene (total) (95-47-6) VD = 5.2 IE = 8.6 eV	TLV: 100 ppm STEL: 150 ppm.	Ih, Ig, Con	Headache, loss of appetite, nervousness and pale skin, skin rash, eye damage, damage to bone marrow, causing low blood cell count, liver and kidney damage	Skin, eyes, blood, liver, kidneys	No
Asbestos (12001-29-5) VD–N/A	TLV: 0.1 fiber/cc PEL: 0.1 fiber/cc Excursion limit: 1 fiber/cc in 30 minutes (29 CFR 1926.1101).	Ih, Ig, Con	Irritation of eyes and skin, chronic asbestosis, restricted pulmonary function	Eyes, respiratory tract, lung lining	A1 – ACGIH Yes – NTP Yes – IARC Yes – OSHA

Table 2-4. (continued).

Material or Chemical (Chemical Abstract Service Number, Vapor Density, and Ionization Energy)	Exposure Limit (PEL/TLV)	Routes of Exposure	Indicators or Symptoms of Overexposure (Acute and Chronic)	Target Organs and System	Carcinogen? (source)
Beryllium (7440-41-7) VD = N/A	TLV: 0.002 mg/m^3 STEL: 0.01 mg/m^3.	Ih, Con	Berylliosis, anorexia, weight loss, weakness, chest pain, cough, clubbing of fingers, cyanosis, pulmonary insufficiency, irritation eyes, dermatitis	Eyes, skin, respiratory system	Yes – NTP Yes – IARC NO – OSHA
Cadmium (7440-43-9) VD = N/A	TLV: 0.01 mg/m^3 Respirable: 0.002 mg/m^3 PEL: 5 µg/m^3 Action level: 2.5 µg/m^3 (29 CFR 1926.1127).	Ih, Ig	Pulmonary edema, dyspnea, cough, chest tightness, substernal pain, headache, chills, muscle aches, nausea, vomiting, diarrhea, anosmia, emphysema, proteinuria, mild anemia	Respiratory system, kidneys, prostate, blood	Yes – NTP Yes – IARC A2 – ACGIH Yes – OSHA
Lead (7439-92-1) VD = N/A	TLV: 50 µg/m^3 **OR** A PEL in µg/m^3 equal to 400 divided by the number of hours worked per day for shifts longer than 8 hours (29 CFR 1926.62).	Ih, Ig, Con	Weakness, lassitude, insomnia, facial pallor, anorexia, weight loss, malnutrition, constipation, abdominal pain, colic, anemia, gingival lead line, tremor, paralysis wrist, ankles, encephalopathy, kidney disease, irritation eyes, hypotension	Eyes, gastrointestinal, central nervous system, kidneys, blood, gingival tissue	No
Lithium oxide (12057-24-8) VD = N/A	None established.	Ih, Ig, Con	Corrosive to eyes, skin, nose, and throat	Skin and eyes (corrosive)	No
Mercury	TLV: 0.025 mg/m^3—skin STEL: 0.03 mg/m^3.	Ih, Ig, Con	Irritation of eyes and skin, cough, chest pain, dyspnea, bronchitis pneumonitis, tremor, insomnia, irritability, indecision, headache, fatigue, weakness, stomatitis, salivation, gastrointestinal disturbance, anorexia, weight loss, proteinuria	Eyes, skin, respiratory system, central nervous system, kidneys	No
Potassium chloride (7447-40-7) VD = N/A	None established.	Ih, Ig, Con	Eyes, irritation of mucous membranes	None identified, primarily a localized irritant	No

Table 2-4. (continued).

Material or Chemical (Chemical Abstract Service Number, Vapor Density, and Ionization Energy)	Exposure Limit (PEL/TLV)	Routes of Exposure	Indicators or Symptoms of Overexposure (Acute and Chronic)	Target Organs and System	Carcinogen? (source)
Potassium cyanide (151-50-8) VD = N/A	PEL: 5 mg/m^3.	Ih, Ig, Con	Irritation of eyes, skin, and upper respiratory system; asphyxia; lassitude (weakness, exhaustion); headache; confusion; nausea; vomiting; increased respiratory rat; slow gasping respiration; thyroid; blood changes	Eyes, skin, respiratory system, cardiovascular system, central nervous system, thyroid, blood	No
Potassium dichromate (7778-50-9) VD = N/A	TLV: 0.05 mg/m^3 (chromate).	Ih, Ig, Con (chromate)	Respiratory, eyes, dermis, skin irritation, discoloration, mucous membrane ulcerating, perforated septum (chromate)	Skin (chromate)	Yes – NPT Yes – IARC No – Z List No – OSHA (chromate)
Potassium nitrate (7757-79-1) VD = N/A	None established.	Ih, Ig, Con	Respiratory irritation, (ingestion, gastrointestinal pain, nausea, and vomiting)	None identified, primarily a localized irritant	No
Potassium phosphate (7778-77-0) VD = N/A	None established.	Ih, Ig, Con	Eyes, minor skin irritation	None identified, primarily a localized irritant	No
Potassium sulfate (7778-80-5) VD = N/A	None established.	Ih, Ig	None identified	None identified	No
Silver (7440-22-4) VD = N/A	TLV: 0.1 mg/m^3 TLV: 0.01 mg/m^3 (soluble compounds as silver).	Ih, Ig, Con	Blue-gray eyes, nasal septum, throat and skin irritation, ulceration skin, gastrointestinal disturbance	Nasal septum, skin, eyes	No
Sodium chloride (7647-14-5) VD = N/A	None established.	Ih, Ig, Con	Eyes, irritation of mucous membranes	None identified, primarily a localized irritant	No
Sodium cyanide (143-33-9) VD = N/A	PEL: 5 mg/m^3.	Ih, Ig, Con	Irritation of eyes and skin, asphyxia, lassitude (weakness, exhaustion), headache, confusion, nausea, vomiting, increased respiratory rate, slow gasping respiration, thyroid, blood changes	Eyes, skin, cardiovascular system, central nervous system, thyroid, blood	No

Table 2-4. (continued).

Material or Chemical (Chemical Abstract Service Number, Vapor Density, and Ionization Energy)	Exposure Limit (PEL/TLV)	Routes of Exposure	Indicators or Symptoms of Overexposure (Acute and Chronic)	Target Organs and System	Carcinogen? (source)
Sodium dichromate (10588-01-9) VD = N/A	TLV—0.05 mg/m^3 (chromate).	Ih, Ig, Con (chromate)	Respiratory, eyes or skin irritation, ulcerating (chromate)	Kidneys, liver (chromate)	Yes – NPT Yes – IARC Yes – Z List Yes – OSHA (chromate)
Sodium nitrate (7631-99-4) VD = N/A	None established.	Ih, Ig, Con	Respiratory, eyes, dermis, (inhalation or ingestion may cause cyanosis)	None identified, primarily a localized irritant	No
Sodium phosphate (7558-79-4) VD = N/A	None established.	Ih, Ig, Con	Respiratory, eyes, dermis	None identified, primarily a localized irritant	No
Sodium sulfate (7757-82-6) VD = N/A	None established.	Ih, Ig, Con	Respiratory, eyes, dermis	None identified, primarily a localized irritant	No
Zirconium (7440-67-7) VD = N/A	TLV: 5 mg/m^3 STEL: 10 mg/m^3.	Ih, Con	Skin, lung granulomas, irritation skin, mucous membrane; x-ray evidence of retention in lungs	Skin, respiratory system	No
Radionuclides (radiation fields)	ALARA dose limit in accordance with RWP. Posting of radiation areas in accordance with "Radiological Control Manual" (PRD-183). Thermoluminescent dosimeters will be used to measure whole-body total effective dose equivalent.	Whole body	Alarming electronic dosimetry or stationary radiation monitors or alarms, criticality alarm, and elevated readings on direct-reading instruments	Blood-forming cells, gastrointestinal tract, and rapidly dividing cells	Yes – IARC

Table 2-4. (continued).

Material or Chemical (Chemical Abstract Service Number, Vapor Density, and Ionization Energy)	Exposure Limit (PEL/TLV)	Routes of Exposure	Indicators or Symptoms of Overexposure (Acute and Chronic)	Target Organs and System	Carcinogen? (source)
Radionuclides (fixed and removable surface contamination)	ALARA dose limit in accordance with RWP. Posting of contamination areas in accordance with "Radiological Control Manual" (PRD-183).	Ih, Ig, broken skin	Alarming constant air monitors, high counts on portable air samplers, direct-reading instruments, swipe counter (scaler), and alarm indication on personal contamination monitors	Gastrointestinal tract, ionization of internal tissue through uptake of radionuclides	Yes – IARC
Radionuclides (airborne radioactivity)	ALARA dose limit in accordance with RWP 10% of derived air concentration for specific radionuclide selected (10 CFR 835). Posting of airborne radioactivity areas in accordance with "Radiological Control Manual" (PRD-183).	Ih, Ig, broken skin	Alarming constant air monitors, high counts on portable air samplers, and personal air samplers	Gastrointestinal tract, ionization of internal tissue through uptake of radionuclides	Yes – IARC

Abs = absorption
ACGIH = American Conference of Government Industrial Hygienists
ALARA = as low as reasonably achievable
Con = contact
IARC = International Agency for Research on Cancer
Ig = ingestion
Ih = inhalation
NIOSH = National Institute of Occupational Safety and Health
NTP = National Toxicology Program
OSHA = Occupational Safety and Health Administration
PEL = permissible exposure limit
RWP = radiological work permit
STEL = short-term exposure limit
TLV = threshold limit value
TWA = time-weighted average

Table 2-5. Summary of project operational activities, associated hazards, and mitigation.[a]

Activity or Task	Associated Hazards or Hazardous Agent	Hazard Mitigation
Construction – Site Development and Utilities		
• Overburden removal • Site excavation • Site grading and pad construction	Radiological: Contamination—waste material Radiation exposure—waste material Airborne radioactivity—dust from waste material	Controlled access, qualified equipment operator, use of dust suppression measures, RWP, RCT coverage, direct-reading instruments, air monitoring equipment, compliance with "Radiological Control Manual" (PRD-183) radiological posting requirements, PPE, use of TLDs and supplemental dosimetry, and contamination surveys.
• Utilities connection and installation • Equipment/facility placement	Chemical and nonradiological contaminants—waste material, airborne contaminants, chemical use for project construction, equipment operation (CO), excavator fuel, and preventive maintenance	Controlled access, IH monitoring as appropriate using direct reading instruments or personnel monitoring based in IH judgment, follow JSAs, MSDS for all chemicals brought onsite, natural ventilation of areas, all personnel shall leave the area and notify IH if unusual odors are detected by personnel.
	Pinch points and struck-by or caught-between hazards—equipment movement and vehicle traffic, forklift movement, and hoisting and rigging	"Hoisting and Rigging" (PRD-2007) requirements, equipment inspections, qualified equipment operators (hoisting and rigging) and forklift operators, backup alarms, controlled access, JSAs, designated traffic lanes and areas, watch body position, and PPE.
	Elevated work—falls from heights on elevated surfaces, aerial lifts, and ladders	Fall protection in accordance with "Fall Protection" (PRD-2002), aerial lifts in accordance with "Aerial Lifts and Elevating Work Platforms" (PRD-2006), and ladder work in accordance with "Ladders" (PRD-2003).
	Excavation hazards—overburden removal, facility foundation excavation, utilities excavation, and other earth work and excavations	Control access, and maintain safe perimeter around holes, pits, or excavations with proper slopes for stability in accordance with "Excavations and Surface Penetrations" (PRD-2014) competent person inspections.
	Hoisting and rigging—equipment and component movement and placement, and project overhead hoists	Qualified operators, equipment and rigging inspections, and hoisting and rigging operations in accordance with "Hoisting and Rigging" (PRD-2007).
	Lifting and back strain—staging equipment and support materials, and manual excavation of overburden	Mechanical equipment to lift and position heavy items, proper lifting techniques, two-person lifts if items are over 50 lb (or one-third of the person's body weight, whichever is less) or awkward or unbalanced, and body position awareness.

Table 2-5. (continued).

Activity or Task	Associated Hazards or Hazardous Agent	Hazard Mitigation
	Heat and cold stress—working outdoors and tasks requiring use of protective clothing and respiratory protection	Work-area temperature monitoring, PPE, training, work and rest cycles as required (MCP-2704), and stay times if required are documented on SWP.
	Tripping hazards and working and walking surfaces—uneven surfaces and terrain, ice-, snow-, mud-covered or wet surfaces, probes in pit, lines and cords, ladders, and SDA subsidence	Good housekeeping, awareness of walking surfaces, salt and sand icy areas (where beneficial), and use of nonskid or high-friction materials on walking surfaces, lines, and cords maintained out of established aisles and walkways, proper footwear, and three-point contact when ascending and descending ladder. Follow SDA subsidence rules when in effect and personnel awareness of subsidence signs (i.e., cracks and depressions, holes in overburden, and voids).
	Stored energy sources—elevated materials, electrical, battery-powered tools and equipment, compressed gases, hoisting and rigging, fire (refueling), and running vehicles	Secure all materials stored at elevated locations; identify and mark all utilities; ensure all lines and cords are checked for damage and continuity; use GFCI (circuit or receptacle) for all outdoor equipment and for all temporary installation; comply with minimum clearances for overhead line; process outage for buried lines and secure compressed cylinders, caps, and bottles before movement; conduct inspections of equipment, grounding and bonding during all refueling operations; set brake and use tire chocks where appropriate; and do not leave any running vehicles or equipment unattended.
	Hazardous noise—areas around equipment and when operating equipment	Source identification and labeling, IH sound-level monitoring and dosimetry, isolation, and PPE (as required).
	Lasers	Follow requirements in PRD-2112, "Lasers," for the laser handling, training, and exposure requirements.
	Confined spaces	Follow PRD-2110, "Confined Spaces," requirements for evaluating and working in confined spaces.
Construction – Retrieval Enclosure, Airlock, and Storage Enclosure Installation		

Table 2-5. (continued).

Activity or Task	Associated Hazards or Hazardous Agent	Hazard Mitigation
• Assembly of the Retrieval Enclosure • Assembly of the airlock • Installation of equipment and support facilities • Assembly of waste enclosure	Radiological: Contamination—waste material Radiation exposure—waste material Airborne radioactivity—dust from waste material	Controlled access, qualified equipment operator, use of dust suppression measures, RWP, RCT coverage, direct-reading instruments, air monitoring equipment, compliance with "Radiological Control Manual" (PRD-183) radiological posting requirements, PPE, use of TLDs and supplemental dosimetry, and contamination surveys.
	Chemical and nonradiological contaminants—waste material, airborne contaminants, chemical use for project construction, equipment operation (CO), excavator fuel, and preventive maintenance	Controlled access, IH monitoring as appropriate using direct reading instruments or personnel monitoring based in IH judgment, follow JSAs, MSDS for all chemicals brought onsite, natural ventilation of areas, all personnel shall leave the area and notify IH if unusual odors are detected by personnel.
	Pinch points, and struck-by or caught-between hazards—equipment movement and vehicle traffic, and forklift movement	"Hoisting and Rigging" (PRD-2007) requirements, equipment inspections, qualified equipment operators and forklift operators, backup alarms, controlled access, JSAs, designated traffic lanes and areas, watch body position, and PPE.
	Hoisting and rigging—equipment and component movement and placement, and project overhead hoists	Qualified operators, equipment and rigging inspections, and hoisting and rigging operations in accordance with "Hoisting and Rigging" (PRD-2007).
	Elevated work—falls from heights on elevated surfaces, aerial lifts, and ladders	Fall protection in accordance with "Fall Protection" (PRD-2002), aerial lifts in accordance with "Aerial Lifts and Elevating Work Platforms" (PRD-2006), and ladder work in accordance with "Ladders" (PRD-2003).
	Excavation hazards—overburden removal, facility foundation excavation, utilities excavation, and other earth work and excavations	Control access, and maintain safe perimeter around holes, pits, or excavations with proper slopes for stability in accordance with "Excavations and Surface Penetrations" (PRD-2014) competent person inspections. Follow "Heavy Industrial Vehicles" (PRD-2020).
	Lifting and back strain—staging equipment and support materials, and manual excavation of overburden	Mechanical equipment to lift and position heavy items, proper lifting techniques, two-person lifts if items are over 50 lb (or one-third of the person's body weight, whichever is less) or awkward or unbalanced, and body position awareness.

Table 2-5. (continued).

Activity or Task	Associated Hazards or Hazardous Agent	Hazard Mitigation
	Stored energy sources—elevated materials (drums and hoisted materials and waste), electrical, battery-powered tools and equipment, and running industrial vehicles (e.g., forklift)	Secure all materials stored at elevated locations, inspect all lines and cords before use, use GFCI (circuit or receptacle) for all outdoor equipment and where liquids may be present, conduct inspections of tools, set brake and use tire chocks where appropriate, and do not leave any running vehicles or equipment unattended.
	Heat and cold stress—working outdoors and tasks requiring use of protective clothing and respiratory protection	Work-area temperature monitoring, PPE, training, work and rest cycles as required (MCP-2704), and stay times if required are documented on SWP.
	Tripping hazards and working and walking surfaces—uneven surfaces and terrain, mud-covered or wet surfaces, lines and cords, ladders, and SDA subsidence	Good housekeeping, awareness of walking surfaces, lines and cords maintained out of established aisles and walkways, proper footwear, and three-point contact when ascending and descending ladder. Follow SDA subsidence rules when in effect and personnel awareness of subsidence signs (i.e., cracks and depressions, holes in overburden, and voids).
	Elevated work—falls from heights on elevated surfaces, aerial lifts, and ladders	Fall protection in accordance with "Fall Protection" (PRD-5096), aerial lifts in accordance with "Aerial Lifts and Elevating Work Platforms" (PRD-5107), and ladder work in accordance with "Ladders" (PRD-5067).
	Hazardous noise—equipment operations	Source identification and labeling, IH sound-level monitoring or dosimetry, isolation, and PPE (as required).
	Lasers	Follow requirements in PRD-2112, "Lasers," for the laser handling, training, and exposure requirements.
	Confined spaces	Follow PRD-2110, "Confined Spaces," requirements for evaluating and working in confined spaces.
Operations – Waste Retrieval and Handling in Retrieval Enclosure		
• Waste excavation • Waste-container handling	Radiological: Contamination—waste material Radiation exposure—waste material	Engineering controls, controlled access, TPRs, qualified positions (where required), RWP, direct-reading instruments, collection and counting of swipes, compliance with "Radiological Control Manual" (PRD-183) radiological posting requirements, PPE, use of TLDs and supplemental dosimetry, and contamination surveys.

Table 2-5. (continued).

Activity or Task	Associated Hazards or Hazardous Agent	Hazard Mitigation
• RCT surveys and monitoring • General tasks inside Retrieval Enclosure	Chemical and nonradiological contaminants—waste excavation and container handling, chemical use for project operations, equipment operation, refueling, preventive maintenance, and cryogenics (LN_2) for assay detector cooling	Engineering controls; controlled access; area monitors and direct-reading instruments; TPRs; JSAs; MSDS for all chemicals used; compliance with "Cryogenic Liquids" (PRD-5038), requirements for cryogenic use and handling; and PPE.
	Pinch points, struck-by or caught-between hazards—equipment, drum movement, forklift operations, and material-handling tasks	Technical procedures, equipment inspections, qualified forklift operators, JSAs, backup alarms, designated traffic lanes and areas, control area around equipment, proper body position, and PPE.
	Excavation hazards—waste excavation and removal and other earth work and excavation	Control access; maintain safe perimeter around holes, pits, or excavations with proper slopes for stability in accordance with "Excavation and Surface Penetration" (PRD-22); and daily competent person inspections. Implement "Heavy Industrial Vehicles" (MCP-2745).
	Lifting and back strain—material handling, handling and positioning waste containers, and sample movement	Mechanical lifting devices (e.g., forklift) to lift and move heavy waste items, proper lifting techniques, two-person lifts if items are over 50 lb (or one-third of the person's body weight, whichever is less) or awkward or unbalanced, and awareness of body position. An IH may perform ergonomic assessments as deemed appropriate.
	Heat and cold stress—support work outdoors	Implement "Heat and Cold Stress" (MCP-2704) monitoring by IH, PPE, training, and work-rest cycles (as required).
	Tripping hazards and working and walking surfaces—uneven surfaces and terrain, ice-, snow-, mud-covered or wet surfaces, lines and cords, entry into waste storage area, and ladders	Good housekeeping, awareness of walking surfaces, salt and sand icy areas (where beneficial), and use of nonskid or high-friction materials on walking surfaces, lines and cords maintained out of established aisles and walkways, proper footwear, and three-point contact when ascending and descending ladder. Follow SDA subsidence rules when in effect, personnel awareness of subsidence signs (i.e., cracks and depressions, holes in overburden, and voids).
	Stored energy sources—elevated materials (stored drums and waste), compressed gas, battery-powered tools and equipment, and running industrial vehicles (e.g., forklift)	Secure all materials stored at elevated locations; inspect all lines and cords before use; use GFCI (circuit or receptacle) for all outdoor equipment and where liquids may be present; secure compressed cylinders, caps, and bottles before movement; conduct inspections of tools; set brake and use tire chalks where appropriate; and do not leave any running vehicles or equipment unattended.

Table 2-5. (continued).

Activity or Task	Associated Hazards or Hazardous Agent	Hazard Mitigation
	Electrical—use of electrical equipment or equipment in area where water or wet surfaces are present	Use of GFCI outlets or extension cords outdoors and where water or wet surfaces are present. Use of barrier material to isolate electrical cords from water.
	Hazardous noise—areas around equipment and when operating some equipment or while using hand tools	Source identification and labeling, IH sound-level monitoring or dosimetry, isolation, and PPE (as required).
Waste Handling and Decontamination in Airlock and Gloveports		
• Waste sorting, inspection, and sampling • Waste-container handling and decontamination • Waste handling and transfer	Radiological: Contamination—waste material Radiation exposure—waste material	Engineering controls, controlled access, TPRs, qualified positions (where required), RWP, direct-reading instruments, collection and counting of swipes, compliance with "Radiological Control Manual" (PRD-183) radiological posting requirements, PPE, use of TLDs and supplemental dosimetry, and contamination surveys.
	Chemical and nonradiological contaminants—contaminants associated with decontamination process and secondary waste streams generated	Controlled areas, JSAs, SWPs (as required), air monitoring and sampling, direct-reading instruments, TPRs, and PPE.
	Pinch points, struck-by, and caught-between hazards—positioning items to be sampled and decontaminated	Technical procedures, equipment inspections, qualified forklift operators, JSAs, backup alarms, designated traffic lanes and areas, proper body position, and PPE.
	Lifting and back strain—moving and positioning components and decontamination of waste containers	Use mechanical lifting devices where possible, proper lifting techniques and two-person lifts if items are over 50 lb (or one-third of the person's body weight, whichever is less) or in awkward or unbalanced situations, and an IH will conduct ergonomic evaluation of tasks (as required).
	Heat and cold stress—working in PPE	Engineering controls—maintain room temperatures cool or warm as appropriate. Monitoring by IH, PPE, training, and work-rest cycles as required (MCP-2704).
	Electrical—use of electrical equipment in area where water or wet surfaces are present	Use of GFCI outlets or extension cords outdoors and where water or wet surfaces are present. Use of barrier material to isolate electrical cords from water.
	Tripping hazards and working and walking surfaces—uneven surfaces and terrain, and ice- and snow-covered and wet surfaces	Awareness of walking surfaces, salt and sand icy areas, use nonskid or high-friction materials on walking surfaces, and wear adequate footwear with traction sole.

Table 2-5. (continued).

Activity or Task	Associated Hazards or Hazardous Agent	Hazard Mitigation
	Fall hazards—ladders and elevated work surfaces	Fall protection in accordance with "Fall Protection" (PRD-5096), aerial lifts in accordance with "Aerial Lifts and Elevating Work Platforms" (PRD-5107), and ladder work in accordance with "Ladders" (PRD-5067).
Maintenance of Project Systems		
• Electrical • Piping, valves, fittings, and hoses • Communication • Heating and ventilating • Mechanical equipment	Radiological contamination—contact with waste material, contaminated equipment, and components Radiation exposure—in close proximity to waste containers and contamination with associated dose rate	Engineering controls (confinement and ventilation), RWP, RCT surveys, work package hold points, direct-reading instruments, collection and counting of swipes, compliance with "Radiological Control Manual" (PRD-183) radiological posting requirements, PPE, use of dosimetry and survey requirements, and as low as reasonably achievable principles.
	Chemical and inorganic contaminants—contact with waste material, contaminated equipment, and components; hydraulic fluids; fuel; and use of chemicals associated with maintenance tasks	Controlled areas, JSAs, SWPs (as required), work package hold points, air monitoring and sampling, direct-reading instruments, MSDS for all chemicals, and PPE.
	Pinch points, struck-by or caught-between hazards—equipment, drum movement, forklift operations, and material-handling tasks	Technical procedures, equipment inspections, qualified forklift operators, JSAs, designated traffic lanes and areas, backup alarms, watch body position, and PPE.
	Lifting and back strain—moving and positioning components	Use mechanical lifting and positioning devices, proper lifting techniques, and two-person lifts if items are over 50 lb (or one-third of the person's body weight, whichever is less) or awkward and unbalanced, and IH conduct ergonomic evaluation of tasks (as required).
	Heat and cold stress—working outdoors and in PPE	Industrial hygienist monitoring, PPE, training, work-rest cycles as required (MCP-2704), and stay times documented on SWP (or equivalent).
	Tripping hazards and working-walking surfaces—uneven surfaces and terrain, ice- and snow-covered and wet surfaces, and ladders	Awareness of walking surfaces, salt and sand icy areas, use nonskid or high-friction materials on walking surfaces, wear adequate footwear with traction sole, and three-point contact when ascending and descending ladder.

Table 2-5. (continued).

Activity or Task	Associated Hazards or Hazardous Agent	Hazard Mitigation
	Hoisting and rigging—equipment and component movement and placement, and project overhead hoists	Qualified operators; equipment and rigging inspections; hoisting and rigging operations in accordance with "Hoisting and Rigging Operations" (MCP-6501), "Hoisting and Rigging Maintenance" (MCP-6502), "Inspection and Testing of Hoisting and Rigging Equipment" (MCP-6503), "Hoisting and Rigging Lift Determination and Lift Plan Preparation" (MCP-6504), and "Hoisting and Rigging Training" (MCP-6505); and applicable facility supplement.
	Stored energy—electrical, mechanical, thermal, battery-powered equipment and tools, elevated materials, pressurized systems, cylinders, and fire systems	Piping and conduit labeling; lockout and tagout training; "Integrated Work Control Process" (STD-101) work packages; and lockout and tagout in accordance with "Chapter IX Level I Lockouts and Tagouts" (MCP-3650), "Chapter IX Level II Lockouts and Tagouts" (MCP-3651), and "Chapter IX-Lockout and Tagout" (PRD-5051).
	Elevated work or work near open excavation	Fall protection training, use of fall protection system and devices, fall protection competent person, and follow all requirements of "Fall Protection" (PRD-5096).
Operations – Waste-Container Assay		
• Waste-container handling • Source handling and calibration • Liquid nitrogen handling	Radiological: Contamination—waste material Radiation exposure—hot particles or dose rate associated with waste-container and source handling	Engineering controls (ventilation and shielding), controlled areas, TPRs, RWP, RCT surveys, fixed and portable air-sampling instruments, hold points, direct-reading instruments, collection and counting of swipes, compliance with "Radiological Control Manual" (PRD-183) radiological posting requirements, PPE, use of dosimetry and survey requirements, and as low as reasonably achievable principles.
	Chemical and nonradiological contaminants—contaminants associated with waste, compressed gas cylinders, and liquid nitrogen	Controlled areas, engineering controls (ventilation), TPRs, JSAs, SWPs (as required), MSDS for chemicals used (LN_2), implement "Cryogenic Liquids" (PRD-5038), sampling, direct-reading instruments, and PPE.
	Pinch points, struck-by, or caught-between hazards—vehicle and equipment movement, and material and equipment handling	Vehicles use traffic lanes and ramps, backup alarms on heavy equipment and industrial vehicles, JSAs, TPRs, watch body position, and wear PPE.

Table 2-5. (continued).

Activity or Task	Associated Hazards or Hazardous Agent	Hazard Mitigation
	Lifting and back strain—moving and positioning waste containers, positioning equipment, equipment and supplies or components	Use mechanical lifting devices where possible, proper lifting techniques and two-person lifts if items are over 50 lb (or one-third of the person's body weight, whichever is less) or awkward and unbalanced, and IH conduct ergonomic evaluation of tasks (as required).
	Heat and cold stress—working outdoors and in PPE	Industrial hygienist monitoring, PPE, training, work-rest cycles as required (MCP-2704), and stay times documented on SWP (or equivalent).
	Tripping hazards and working-walking surfaces—uneven surfaces and terrain; ice- and snow-covered and wet surfaces; plastic sheeting; cords, hoses, and lines; and ladders	Awareness of walking surfaces, salt and sand icy areas, and use nonskid or high-friction materials on walking surfaces, keep lines and cords out of established aisles and walkways, and wear adequate footwear with traction sole.
	Electrical—use of electrical equipment or equipment in area where water or wet surfaces are present	Use of GFCI outlets or extension cords outdoors and where water or wet surfaces are present. Use of barrier material to keep electrical cords out of water.

a. All hazards will be identified and evaluated, and controls will be established in accordance with "Activity Level Hazard Identification, Analysis, and Control" (PRD-25) requirements. Additionally, project-assigned IH, safety professional, and Radiological Control personnel will be available to assist with the "Activity Level Hazard Identification, Analysis, and Control" process and to assist in the develop of TPRs, work orders or packages, and permits associated with project operational activities.

GFCI = ground-fault circuit interrupter
IH = industrial hygienist
JSA = job safety analysis
MSDS = material safety data sheet
PPE = personal protective equipment
RCT = radiological control technician
RWP = radiological work permit
SDA = Subsurface Disposal Area
SWP = safe work permit
TLD = thermoluminescent dosimeter
TPR = technical procedure

2.2 Safety and Physical Hazards and Mitigation

Industrial safety and physical hazards will be encountered while performing project operations. Section 4.2 provides general safe work practices that must be followed at all times. This section describes specific industrial safety hazards and procedures to be followed to eliminate or minimize safety and physical hazards that will be encountered by project personnel.

2.2.1 Material Handling and Back Strain

Material handling and maneuvering of various pieces of equipment, drums, end-effector stands, and waste in the Packaging Glovebox System during project operations may result in employee injury. Mechanical lifting devices such as hoists and forklifts will be used wherever possible to eliminate the need for manual materials handling and lifting. Where these devices are not feasible, lifting and material-handling tasks will be performed in accordance with "Ergonomics Program" (MCP-2692). Construction personnel shall follow "Material Handling, Storage, and Disposal" (PRD-2016). Personnel will not physically lift objects weighing more than 50 lb or 33% of their body weight alone (whichever is less).

2.2.2 Working and Walking Surfaces

Slippery and uneven work surfaces can increase the likelihood of back injuries, overexertion injuries, slips, and falls. Project operations inside the Retrieval Enclosure and airlock will present potential tripping or slip hazards from uneven flooring surfaces, equipment cords or hoses, pit surface subsidence after overburden excavation, and wet surfaces or floor obstructions. Outside the Retrieval Enclosure and airlock, the potential for slip, trip, and fall hazards will increase during winter months because of ice- and snow-covered surfaces. All personnel will be made aware of tripping hazards that cannot be eliminated by marking them (e.g., probes). All construction and operations personnel will wear required protective footwear with adequate sole traction to further mitigate slip and fall potential. Tripping and slip hazards will be evaluated during the course of project operations in accordance with "Walking and Working Surfaces" (PRD-5103) and during construction in accordance with "Walking and Working Surfaces" (PRD-2005).

The floor of the Retrieval Enclosure and airlock shall be maintained, so far as possible, in a clean and dry condition. All walking and working surfaces will be kept clean, orderly, and free of foreign objects to prevent possible slip, trip, and fall hazards. Proper drainage and use of dry standing stations will be considered for use and implemented as determined necessary where wet processes (e.g., decontamination) are used that could cause a potential slip and fall hazard. All tools and equipment used during each shift will be placed back in the designated storage location, unless required to be left in place. Cords and lines will be routed around walkways, traffic lanes, stairs, and entrances and exits to eliminate tripping hazards. Elevated walkways and platforms will be kept clear of potential tripping hazards at all times.

2.2.3 Elevated Work Areas

Personnel performing construction, maintenance tasks, or other operations may be required to work on elevated equipment or at heights above 1.8 m (6 ft). Personnel required to access the area around the excavation shall be protected from falling by the use of barricades positioned 1.8 m (6 ft) back from the edge as directed by excavation-competent person in accordance with "Excavation and Surface Penetration" (PRD-22) or "Excavations and Surface Penetrations" (PRD-2014) for construction personnel. Personnel shall use guardrail systems, personal fall-arrest systems, or fall-restraint system (travel restriction system) that prevents personnel from a fall hazard in accordance with "Fall Protection" (PRD-5096) or "Fall Protection" (PRD-2002) for construction personnel.

Additionally, the following MCP requirements will be followed as they relate to project operations associated with elevated work:

- "Aerial Lifts and Elevating Work Platforms" (PRD-5107) (operations)
- "Aerial Lifts and Elevating Work Platforms" (PRD-2006) (construction)
- "Ladders" (PRD-5067) (operations)
- "Ladders" (PRD-2003) (construction)
- "Scaffolding" (PRD-5098) (operations)
- "Scaffolding" (PRD-2004) (construction).

2.2.4 Means of Egress

Established means of egress (continuous and unobstructed way of travel to an exit, exit access, and exit discharge) shall be maintained within all Retrieval Enclosure and airlock areas in accordance with "Life Safety Code" (NFPA 101) requirements. This includes emergency lighting, illumination of signs, and marking of means of egress in accordance with the fire hazards analysis for the Accelerated Retrieval Project.

2.2.5 Powered Equipment and Tools

Powered equipment and tools will be used during project construction and operations. Use of this equipment presents potential physical hazards (e.g., pinch points, electrical hazards, flying debris, and struck-by and caught-between hazards) to personnel operating them. All portable equipment and tools will be properly maintained and used by qualified individuals and in accordance with the manufacturer's specifications. At no time will safety guards be removed. Requirements from "Portable Equipment and Handheld Power Tools" (PRD-5101) will be followed for all work performed with powered equipment including hand tools by operations and maintenance personnel. Construction personnel shall implement the requirements in "Hand and Portable Power Tools" (PRD-2015). All tools will be inspected by the user before use.

2.2.6 Electrical Hazards and Energized Systems

Electrical equipment and tools, as well as construction and maintenance of project facility electrical systems, may pose shock or electrocution hazards to personnel. Ground-fault-protected electrical circuits and receptacles in combination with safety-related work practices will be employed to prevent electric shock or other injuries resulting from direct or indirect electrical contact. All electrical work will be reviewed and completed under the appropriate work controls (e.g., TPRs or work orders). Before conducting electrical work, hazardous energy of the affected system will be brought to a zero energy state through the use of isolation methods in accordance with the following:

- "Chapter IX Level I Lockouts and Tagouts" (MCP-3650) (operations and maintenance)
- "Chapter IX Level II Lockouts and Tagouts" (MCP-3651) (operations and maintenance)
- "Lockouts and Tagouts" (PRD-2012) (construction only).

If work on energized systems during operations or maintenance is necessary, these practices will conform to the requirements in "Electrical Safety" (PRD-5099) or "Electrical Safety" (PRD-2011) for construction personnel. Additionally, all electrical and other utilities will be identified before conducting surface penetration maintenance activities in accordance with "Excavation and Surface Penetration" (PRD-22) for maintenance and operations tasks and "Excavations and Surface Penetrations" (PRD-2014) for construction personnel.

2.2.7 Operational Fire Hazards and Prevention

The "Preliminary Fire Hazards Analysis for the Accelerated Retrieval Project at Area G of Pit 4 within the Radioactive Waste Management Complex" (HAD-266) identifies the fire hazards and mitigations to protect the project facilities and operations. The protective actions and requirements in the fire hazards analysis will be implemented to minimize fire hazards and to protect personnel and property during project tasks.

2.2.8 Flammable and Combustible Material Hazards

Fuel will be required for the heavy equipment, excavator, forklifts, and other equipment during project operations. Flammable hazards include transfer and storage of flammable or combustible liquids in the project construction and operations area. Portable fire extinguishers with a minimum rating of 10A or 60 BC shall be strategically located at the facility to combat Class ABC fires. Portable fire extinguishers will be located in all active project operations areas, on or near all facility equipment that has exhaust heat sources, and on or near all equipment capable of generating ignition or having the potential to spark. The requirements of "Handling and Use of Flammable and Combustible Liquids" (PRD-308) for maintenance and operations and "Flammable and Combustible Liquid Storage" (PRD-2201) for construction activities will be followed at all times. The use of liquefied petroleum at the project site will comply with "National Fuel Gas Code" (NFPA 54) for installation and use. Liquefied petroleum installations will be safely positioned and protected from equipment damage, as appropriate.

2.2.9 Welding, Cutting, or Grinding

Personnel conducting welding, cutting, or grinding tasks may be exposed to molten metal, slag, and flying debris. Additionally, a fire potential exists if combustible materials are not cleared from the work area. Requirements from "Welding, Cutting, and Other Hot Work" (PRD-5110) will be followed whenever these types of activities are conducted by maintenance or operations personnel. The requirements of "Welding, Cutting, and other Hot Work" (PRD-2010) will be implemented during construction activities. This includes the requirement for a hot work permit (documented on an SWP) and designation of a fire watch.

2.2.10 Pressurized Systems

Pressurized plant and breathing air systems will be operated in support of project operations. The hazards presented to personnel, equipment, facilities or the environment because of inadequately designed or improperly operated pressure systems (vessels) include blast effects, shrapnel, fluid jets, equipment damage, personnel injury, and death. These systems can include pneumatic, hydraulic, or compressed-gas systems. The applicable requirements in "Handling and Use of Compressed Gases" (PRD-5040) and "Boilers and Unfired Pressure Vessels" (PRD-5) must be followed as well as the manufacturer's operating and maintenance instructions. This includes inspection, maintenance, and testing of systems and components in accordance with applicable American National Standards Institute requirements.

Additionally, all hoses, fittings, lines, gauges, and system components will be rated for the system for at least the maximum allowable working pressure (generally the relief set point). The project safety professional should be consulted about any questions of pressure systems in use at the project site.

2.2.11 Cryogenics

Cryogenics may be used in support of project operations for cooling of detectors or other applications. If required, all cryogenic tasks will be conducted and protective equipment worn in accordance with "Cryogenic Liquids" (PRD-5038). Personal protective equipment will be worn at all times when handling, transferring, or dispensing cryogenic liquids in accordance with "Cryogenic Liquids" (PRD-5038). Additional hazards associated with cryogenic liquids include the following:

- **Pressure buildup:** Boiling of liquefied gases within a closed system increases pressure. Cryogenic liquids will not be contained in a closed system other than an approved dewar. Cold fingers and similar devices have exploded when either an ice dam has formed within the apparatus or when users created a closed system by shutting off all of the valves.

- **Oxygen enrichment:** Liquid nitrogen may fractionally distill air, causing liquid oxygen to collect in the cryogenic container. Liquid oxygen increases the combustibility of many materials, creating potentially explosive conditions. Adequate venting will be provided when working with cryogenic liquids in a closed system or enclosed space.

- **Asphyxiation:** If vented into a closed space, a cryogenic liquid will vaporize, displacing oxygen and possibly causing asphyxia. Cryogenic liquid will not be stored in a closed space.

- **Embrittlement:** Cryogenic liquids will not be disposed of down any drains. Ordinary materials such as metal or PVC piping may not be able to withstand cryogenic temperatures. Cryogenic liquids will be allowed to evaporate in a well-ventilated area. Materials exposed to cryogenic temperatures for long periods or materials that have undergone periodic warming and freezing will be examined regularly for cracks and warping.

2.2.12 Compressed Gases

Compressed gases will be used in support of project construction, maintenance, and operations. All cylinders will be used, stored, handled, and labeled in accordance with "Handling and Use of Compressed Gases" (PRD-5040) for maintenance and operations activities and "Compressed Gases" (PRD-2009) for construction activities. Additionally, the assigned project safety professional should be consulted about any compressed gas cylinder storage, transport, and use issues.

2.2.13 Heavy Equipment and Vehicle Hazards

Heavy equipment, forklifts, and vehicles will be used as part of the project construction, maintenance, and operations. Hazards associated with the operation of the heavy equipment, forklifts, and vehicles include injury to personnel (e.g., struck-by and caught-between hazards), equipment contact with the structures, and property damage. All equipment will be operated in the manner in which it was intended and in accordance with the manufacturer's instructions or equipment design. Only authorized and qualified personnel will be allowed to operate equipment. Personnel in proximity to operating equipment must maintain visual communication with the operator and stay out of the excavator or crane swing radius, which will be barricaded to protect personnel in the area from being struck, as appropriate based on the configuration. Personnel also must comply with the applicable requirements of the following:

- "Heavy Industrial Vehicles" (MCP-2745) (operations and maintenance)
- "Heavy Industrial Vehicles" (PRD-2020) (construction)
- "Motor Vehicle Safety" (PRD-5123) (operations and maintenance)
- "Motor Vehicle Safety" (PRD-2019) (construction).

2.2.14 Illumination

Construction and operational activities will be conducted with adequate lighting to support safe operations. The minimum illumination in the Retrieval Enclosure and at the construction area will comply with the requirements of "Hazardous Waste Operations and Emergency Response" (29 CFR 1910.120[m]) and "Powered Industrial Trucks" (29 CFR 1910.178[h]).

2.2.15 Excavation, Surface Penetrations, and Outages

Buried utilities or lines are buried in the project area to be excavated. The requirements of "Excavations and Surface Penetrations" (PRD-2014) for construction and "Excavation and Surface Penetration" (PRD-22) for maintenance and operations will be applied to identify and protect from buried utilities and lines. Any required outages will be coordinated with the RWMC outage coordinator, including buried utilities, roads, and overhead power lines.

The requirements of "Excavations and Surface Penetrations" (PRD-2014) for construction and "Excavation and Surface Penetration" (PRD-22) for maintenance and operations will be applied to all excavation activities including overburden removal, building site excavations, utility excavations, and waste excavations.

2.2.16 Hoisting and Rigging of Equipment

All hoisting and rigging during operations and maintenance will be performed in accordance with "Hoisting and Rigging Operations" (MCP-6501), "Hoisting and Rigging Maintenance" (MCP-6502), "Inspection and Testing of Hoisting and Rigging Equipment" (MCP-6503), "Hoisting and Rigging Lift Determination and Lift Plan Preparation" (MCP-6504), "Hoisting and Rigging Training" (MCP-6505), and "Hoisting and Rigging" (DOE-STD-1090-01) as applicable for these project operations. All construction hoisting and rigging activities will be conducted in accordance with the requirements of "Hoisting and Rigging" (PRD-2007).

Hoisting and rigging equipment will show evidence of a current inspection (e.g., tag) and be inspected before use by designated operators. Additionally, if mobile crane or boom trucks are used in support of project operations, the operator or designated person for mobile cranes or boom trucks will perform a visual inspection each day or before use (if the crane has not been in regular service) of items such as, but not limited to, the following:

- All control mechanisms for maladjustment that would interfere with proper operation
- Crane hooks and latches for deformation, cracks, and wear
- Hydraulic systems for proper oil level
- Lines, tanks, valves, pumps, and other parts of air or hydraulic systems for leakage

- Hoist ropes for kinking, crushing, birdcaging, and corrosion
- All anti-two-block, two-block warning, and two-block damage prevention systems for proper operation.

Note: The operator or other designated person will examine deficiencies and determine whether they constitute a safety hazard. If deficiencies are found, they will be reported to the safety professional.

2.2.17 Personal Protective Equipment

Wearing PPE will reduce a worker's ability to move freely, see clearly, and hear directions and noise that might indicate a hazard. In addition, PPE can increase the risk of heat stress. Work activities at the task site will be evaluated by Industrial Hygiene, Industrial Safety, and RadCon as necessary to ensure that personnel are able to work safely in the required PPE. Work-site personnel will comply with "Personal Protective Equipment" (PRD-5121) and "Radiological Personal Protective Equipment" (MCP-432). All personnel who wear PPE will be trained in its use and limitations in accordance with "Personal Protective Equipment" (PRD-5121) for maintenance and operations personnel and "Personal Protective Equipment" (PRD-2001) for construction personnel.

2.3 Environmental Hazards and Mitigation

Potential environmental hazards will present potential hazards to personnel during project operations. These hazards will be identified and mitigated to the extent possible. This section describes these environmental hazards and states what procedures and work practices will be followed to mitigate them.

2.3.1 Noise

Personnel performing project construction, operations, and maintenance activities may be exposed to noise levels from the heavy equipment, hand tools, and compressors that exceed 85 decibel A-weighted (dBA). For an 8-hour time-weighted average (TWA), 84 dBA for 10-hour TWA. The effects of high sound levels (noise) may include the following:

- Personnel being startled, distracted, or fatigued
- Physical damage to the ear and pain and temporary or permanent hearing loss
- Interference with communication that would warn of danger.

Where noise levels are suspected of exceeding 80 dBA, noise measurements will be performed in accordance with "Controlling and Monitoring Exposure to Noise" (MCP-2719) for maintenance or operations and "Hearing Conservation" (PRD-2108) for construction personnel to determine if personnel are routinely exposed to noise levels in excess of the applicable TWA (85 dBA for 8 hours of exposure or lower TWA for 10- or 12-hour work-shift exposures).

Note: Exposures exceeding 8 hours in accordance with day will be evaluated by the assigned project industrial hygienist (IH).

Personnel whose noise exposure routinely meet or exceed the allowable TWA will be enrolled in the INEEL Occupational Medical Program (OMP) (or subcontractor hearing conservation program as

applicable). Personnel working on jobs that have noise exposures greater than 85 dBA will be required to wear hearing protection until noise levels have been evaluated and will continue to wear the hearing protection specified by the IH until directed otherwise.

2.3.2 Heat and Cold Stress

Project operational tasks will be conducted during times when there is a potential for both heat and cold stress that could present a potential hazard to personnel. The assigned IH will be responsible for obtaining meteorological information to determine if additional heat or cold stress administrative controls are required. All construction, maintenance, and operations personnel must understand the hazards associated with heat and cold stress and take preventive measures to minimize the effects. "Heat and Cold Stress" (MCP-2704) guidelines will be followed for maintenance and operations tasks and "Heat and Cold Stress" (PRD-2107) for construction activities when determining work and rest schedules or when to halt work activities because of temperature extremes.

2.3.3 Ultraviolet Radiation Exposure

Personnel will be exposed to ultraviolet (UV) radiation (i.e., sunlight) when conducting project construction, maintenance, and operations outdoors. Sunlight is the main source of UV known to damage the skin and to cause skin cancer. The amount of UV exposure depends on the strength of the light, the length of exposure, and whether the skin is protected. No UV rays or suntans are safe. The following are mitigative actions that should be taken to minimize UV exposure:

- Wear clothing to cover the skin (long pants [no shorts] and long-sleeve or short-sleeve shirt [no tank tops])
- Apply a sunscreen with a sun protection factor of at least 15 to areas exposed to the sun
- Wear a hat (hard hat where required)
- Wear UV-absorbing safety glasses
- Limit exposure during peak intensity hours of 10 a.m. to 4 p.m. whenever possible.

2.3.4 Confined Spaces

Work in confined spaces can subject personnel to risks involving engulfment, entrapment, oxygen deficiency, and toxic or explosive atmospheres. If confined spaces are identified at the Accelerated Retrieval Project site, they will be evaluated in accordance with "Confined Spaces" (MCP-2749) for operations and maintenance activities and "Confined Spaces" (PRD-2110) for construction tasks to determine if they are permit-required. If entry into identified project confined spaces is required, then all requirements of the applicable document will be implemented.

2.3.5 Biological Hazards

The project facilities and support buildings and structures provide habitat for various rodents, insects, and vectors (i.e., organisms that carry disease-causing microorganisms from one host to another). The potential exists for encountering nesting materials or other biological hazards and vectors. Hantavirus may be present in the nesting and fecal matter of deer mice. If such materials are disturbed, it can become airborne and create a potential inhalation pathway for the virus. Contact and improper removal of these materials may provide additional inhalation exposure risks.

If suspected rodent nesting or excrement material is encountered, the assigned IH will be notified immediately and **no attempt will be made to remove or to clean the area**. Following an evaluation of the area, disinfection and removal of such material will be conducted in accordance with "Preventing Hantavirus Infection" (MCP-2750) for operations and maintenance activities and "Disease Control" (PRD-2102) for construction tasks.

Snakes, insects, and arachnids (e.g., spiders, ticks, and mosquitoes) also may be encountered at the project. Common areas to avoid include material stacking and staging areas, under existing structures (e.g., trailers and buildings), under boxes, and other areas that provide shelter. Protective clothing will generally prevent insects from direct contact with the skin. If potentially dangerous snakes or spiders are found or are suspected of being present, warn others, keep clear, and contact the assigned IH for additional guidance as required.

2.3.6 Inclement Weather Conditions

When inclement or adverse weather conditions develop that may pose a threat to persons or property at the project area (e.g., sustained strong winds 25 mph or greater, electrical storms, heavy precipitation, or extreme heat or cold), these conditions will be evaluated and a decision made by the HSO, IH, safety professional, RCT, and other operations personnel, as appropriate, to stop work, employ compensatory measures, or proceed with operations. The shift supervisor and operations personnel shall comply with INEEL MCPs and facility work control documents and design requirements that specify limits for project operations.

During all project activities, assigned health and safety professionals in consultation with RadCon and the shift supervisor will determine if wind or other weather conditions pose unacceptable hazards to personnel or the environment.

2.3.7 Lasers

The use of Class 1, 2, or 3a lasers for AR Project tasks is anticipated and will comply with the training, safe use, and exposure limit requirements of MCP-2717, "Laser Safety Program," for operations or maintenance activities, and PRD-2112, "Lasers," for construction.The use of Class 3b or greater lasers is not anticipated during AR project operations, maintenance, or construction, and must have IH review and concurrence prior to use which shall comply with MCP-2717, "Laser Safety Program."

2.4 Other Project Hazards

Project personnel should continually look for potential hazards and immediately inform the HSO, shift supervisor, or other operations or construction lead personnel of the hazards so that action can be taken to correct the condition. All personnel have the authority to initiate STOP WORK actions in accordance with "Stop Work Authority" (MCP-553) for operations and maintenance personnel and "Stop Work Authority" (PRD-1004) for construction personnel if it is perceived that an imminent safety or health hazard exists or to take corrective actions within the scope of the work control authorization documents to correct minor safety or health hazards and then inform the shift supervisor, HSO, or lead person.

Personnel working at the project are responsible to use safe work practices; report unsafe working conditions, near misses, or acts; and exercise good housekeeping habits during project operations with respect to tools, equipment, and waste.

2.5 Site Inspections

The shift supervisor, IH, HSO, safety professional, RCT, subcontract technical representative, construction personnel, and operations personnel may participate in project site inspections during the work control preparation stage of the project (e.g., the hazard identification and verification walk-downs) and conduct self-assessments or other inspections. Additionally, periodic safety inspections will be performed by the supervisors and assigned health and safety professionals in accordance with "Safety and Health Inspections" (MCP-3449).

Targeted or required self-assessments will be performed during project operations in accordance with "Performing Management Assessments and Management Reviews" (MCP-8) as directed by the operations manager or shift supervisor. All inspections and assessments will be documented and available for review by the shift supervisor, as a minimum. Health and safety professionals present during project operations may, at any time, recommend changes in work habits to the shift supervisor.

3. EXPOSURE MONITORING AND SAMPLING

The potential for exposure to chemical, radiological, and physical hazards exists during Accelerated Retrieval Project construction, maintenance, and operations and will affect all project personnel who are involved with overburden excavation, waste handling, sorting, storage, transporting, and decontamination activities. Refinement of project area access requirements, work control zones (see Section 7), use of engineering and administrative controls, worker training, and wearing PPE provides the mitigation strategy for these hazards. Monitoring and sampling will be used throughout project operations to (1) assess the effectiveness of engineering controls, (2) determine the appropriate PPE requirements for individual tasks, and (3) determine the need for upgrading and downgrading of PPE as described in Section 5. Monitoring with direct-reading, stationary, and mobile instruments will be conducted to provide RadCon and Industrial Hygiene personnel with data to assess the effectiveness of control measures.

3.1 Airborne Exposure Engineering Controls

The Retrieval Enclosure and airlock structure are equipped with ventilation and particulate contamination suppression systems to minimize airborne COCs. The radiological and Industrial Hygiene support personnel will perform monitoring and sampling to determine the effectiveness of the engineering and administrative controls and adequacy of PPE. The Industrial Hygiene exposure assessments and monitoring data will be documented in the Hazards Assessment and Sampling System. Radiological data will be logged and maintained in accordance with the requirements in "Radiological Control Manual" (PRD-183).

3.1.1 Radiological Monitoring

Monitoring for radiological contamination and radiation will be conducted during all phases of the Accelerated Retrieval Project construction, operations, and maintenance using fixed and portable equipment. All project personnel will wear personal dosimetry as required on the RWP. The RCTs will collect and count air samples and smears as necessary to determine airborne and surface contamination levels. Portable or hand-held monitors will be used by RCTs to monitor radiation fields and contamination levels as determined necessary by Bechtel BWXT Idaho, LLC, RadCon. The radiation and contamination levels will be evaluated by the RCTs, RadCon foreman, RadCon supervisor, and radiological engineers as necessary to determine adequacy of the protective controls. Radiological monitoring equipment that might be used is included in Table 3-1.

3.1.2 Industrial Hygiene Monitoring

The Industrial Hygiene monitoring and sampling for nonradiological COCs will be performed by project Industrial Hygiene support personnel for either construction or operations, as appropriate. Monitoring will use direct-reading instruments, air-sampling equipment, environmental-monitoring equipment, and assessment techniques as determined appropriate by the IH based on professional judgment. The Industrial Hygiene equipment that may be used as determined appropriate by the IH is listed in Table 3-1.

Table 3-1. Monitoring instrument category and description.

Instrument Category	Instrument Category Number Description[a]
Radiological	Alpha: Count rate—Bicron NE Electra (DP-6 or AP-5 probe) or equivalent
	Stationary—Eberline RM-25 (HP-380AB or HP-380A probe) or equivalent
	Beta gamma: Count rate—Bicron NE Electra (DP-6, BP-17 probes) or equivalent. Stationary—Eberline RM-25 (HP-360AB probe) or equivalent
	Fissile material monitor
Radiological	Constant air monitor (alpha)—ALPHA 7-A-1 (inline and radial sample heads, pump, RS-485) or equivalent (as required)
	Constant air monitor (beta)—AMS-4 (inline and radial head, pump RS-485) or equivalent (as required)
	Grab sampler—Science Applications International Corporation H-810 or equivalent
Industrial hygiene	Organic vapor: Direct-reading instruments (photoionization detector, flame ionization detector, infrared detector, or other as determined by industrial hygienist), detector tubes or grab samples, or organic vapor monitor canisters or badges
	Dust: Direct-reading instrument (miniram)
Industrial hygiene	Organic vapors and other airborne constituents, particulate or hazardous atmospheres: personal sampling pumps with appropriate media for partial- and full-period sampling using National-Institute-for-Occupational-Safety-and-Health- or Occupation-Safety-and-Health-Administration-validated methods, direct-reading instruments, or remote-sensing detectors
Industrial hygiene	Silica dust, respirable: National Institute for Occupational Safety and Health 7500 or equivalent, personal sampling pump, 10-mm cyclone, full-period sampling
Industrial hygiene	Sound-level meter or dosimeter (A-weighted scale for time-weighed average dosimetry, C-weighted scale for impact-dominant sound environments)
Industrial hygiene	Observation and ergonomic assessment of activities in accordance with "Ergonomic Program " (MCP-2692)
Industrial hygiene	Heat stress: wet-bulb globe temperature, ambient temperature
	Cold stress: ambient air temperature, wind chill charts

a. Equivalent instrumentation other than those listed may be used.

3.2 Exposure Limits

Only controlled and authorized entry into the Retrieval Enclosure will be permitted after start of waste retrieval operations. Radiological Control and Industrial Hygiene personnel will conduct monitoring of project construction and operations with direct-reading instruments and stationary monitors, collect swipes, and conduct full- and partial-period air sampling, as deemed appropriate, in accordance with applicable TPRs, MCPs, and other guidelines. As new project processes or hazards are introduced, each will be evaluated and controlled in accordance with "Activity Level Hazard

Identification, Analysis, and Control" (PRD-25). Action limits should be adjusted as required based on changing site conditions, exposure mitigation practices, and PPE levels. Such changes will be reflected in applicable work control documents, permits, and procedures.

3.3 Environmental and Personnel Monitoring

The potential for exposure to radiological and nonradiological hazards exists during project construction and operations. All project personnel who handle, store, transport, and conduct disposal or decontamination activities will be protected from radiological and nonradiological contaminants to the extent feasible through the use of engineering controls, work controls, and PPE. However, the potential for exposure to these contaminants cannot be eliminated. Environmental and personnel monitoring will be conducted to determine the effectiveness of these exposure control practices and assist health, safety, and radiological professionals in establishing additional administrative controls and PPE requirements.

3.3.1 Industrial Hygiene Area and Personal Monitoring and Instrument Calibration

The assigned Accelerated Retrieval Project IH will conduct full- and partial-period sampling of airborne contaminants and monitoring of physical agents during operations at a frequency deemed appropriate based on direct-reading instrument readings and changing conditions. When performed, all air sampling will be conducted using applicable National Institute of Occupational Safety and Health (NIOSH), OSHA, or other validated method. Both personal and area sampling and remote-sensing monitoring may be conducted.

Various direct-reading instruments may be used to determine the presence of nonradiological and other physical agents. The frequency and type of sampling and monitoring will be determined by Accelerated Retrieval Project conditions, direct-reading instrument results, observation, professional judgment, and in accordance with the "Industrial Hygiene Exposure Assessment" (MCP-153).

All monitoring instruments will be maintained and calibrated in accordance with the manufacturer's recommendations, existing Industrial Hygiene protocol, and in conformance with "Control of Measuring and Test Equipment" (MCP-2391) and the companywide safety and health manuals, *Safety and Health—Occupational Safety and Fire Protection* (Manual 14A) and *Safety and Health—Occupational Medical and Industrial Hygiene* (Manual 14B). Calibration information, sampling and monitoring data, results from direct-reading instruments, and field observations will be recorded as stated in Section 12.

3.3.2 Radiological Monitoring and Instrument Calibration

Radiological instrumentation to be used during Accelerated Retrieval Project operations will include alpha- and beta-gamma equipment as identified by RadCon personnel. The personal contamination monitors (PCMs) for automated whole-body survey will be located at normal egress points. Additionally, scalers, high-volume samplers, lapel samplers, and other instrumentation will be available to collect and quantify radiological contamination levels.

In addition to routine radiological monitoring and sampling instruments and equipment, other instrumentation provided for project operations includes the fissile material monitor system.

Radiological monitoring of radiation and contamination will be conducted during Accelerated Retrieval Project construction and operations to ensure that personnel are given adequate protection from potential radiological exposure. Instruments and sampling techniques listed in Table 3-1 may be used by the RCT as deemed appropriate and as required by general or task-specific RWPs. When conducted,

monitoring will be performed in accordance with *Radiation Protection Procedures* (Manual 15B) and *Radiological Control Procedures* (Manual 15C). The data obtained from monitoring will be used by RadCon personnel to evaluate the effectiveness of project engineering controls and decontamination methods and procedures and to alert personnel to potential radiation or contamination sources.

All portable survey instruments will be source-checked daily to ensure they are within the specified baseline calibration limits. Accountable radioactive sources will be maintained in accordance with "Radioactive Source Accountability and Control" (MCP-137). All radiological survey and monitoring equipment will be maintained and calibrated in accordance with the manufacturer's recommendations, existing RadCon protocol, *Radiation Protection Procedures* (Manual 15B), and "Health Physics Instrumentation" (MCP-93).

3.3.3 Personnel Radiological Exposure Monitoring

Personal radiological monitoring will be conducted during Accelerated Retrieval Project construction and operational activities to quantify radiation exposure and potential for uptakes as stated in the general or task-specific RWP. This will include the use of external dosimetry, surface monitoring, and internal dosimetry methods to ensure that engineering controls, administrative controls, and work practices are effectively mitigating radiological hazards. General as-low-as-reasonably-achievable (ALARA) considerations are discussed further in Section 4.4.

3.3.3.1 External Dosimetry. Dosimetry requirements will be based on the radiation exposure potential during Accelerated Retrieval Project operations. All personnel who enter project construction or operational areas will be required to wear a minimum of a thermoluminescent dosimeter (TLD) and other personal dosimetry devices (e.g., albedo dosimetry) specified by RadCon personnel in applicable RWPs and in accordance with the "Radiological Control Manual" (PRD-183).

The Radiological Control and Information Management System (RCIMS) will be used to track external radiation exposures to project personnel and to serve as the administrative control mechanism for working in accordance with individual RWPs. Individual project personnel are responsible for ensuring all required personal information is provided to RadCon personnel for entry into RCIMS and logging in when electronic dosimeters are used.

3.3.3.2 Internal Monitoring. The purpose of internal dose monitoring is to demonstrate the effectiveness of contamination control practices and to document the nature and extent of any internal uptakes that may occur. Internal dose evaluation programs will be adequate to demonstrate compliance with "Occupational Radiation Protection" (10 CFR 835). The requirement for whole-body counts, lung counts, and bioassays will be based on specific Accelerated Retrieval Project construction and operational evaluations conducted by the assigned radiological engineer. Select project personnel will be entered into a plutonium bioassay program based on the hazards associated with individual job functions. Bioassay requirements will be specified on the RWP, and project personnel will be responsible for submitting required bioassay samples upon request.

4. ACCIDENT AND EXPOSURE PREVENTION

The Accelerated Retrieval Project construction and operations will present numerous safety, physical, chemical, and radiological hazards to personnel conducting these activities. It is critical that all personnel understand and follow the requirements of this HASP. Project facility design features, engineering controls (confinement), hazard isolation, specialized work practices, and the use of PPE will be in place to eliminate or mitigate all potential hazards and exposures. However, given the nature of the Accelerated Retrieval Project scope and the waste material being excavated, all hazards cannot be eliminated. Personnel are responsible for the identification and control of hazards in their respective project work areas in accordance with Integrated Safety Management System (ISMS) principals and practices.

Note: Hazards will not be left unmitigated without implementing some manner of controls or abatement (e.g., engineering controls, administrative controls, or the use of PPE).

Personnel should use stop work authority in accordance with "Stop Work Authority" (MCP-553) or "Stop Work Authority" (PRD-1004) as appropriate and where it is perceived that imminent danger to personnel, equipment, or the environment exists.

This HASP is to be used in conjunction with "Activity Level Hazard Identification, Analysis, and Control" (PRD-25) and Accelerated Retrieval Project work authorization and control documents, such as "Integrated Work Control Process" (STD-101) work orders, JSAs, "Hazard Identification, Analysis, and Control of Operational Activities" (MCP-3562), and operational TPRs. Where appropriate, "Hazard Identification, Analysis, and Control of Operational Activities" (MCP-3562) and "Hazard Mitigation Guide for Integrated Work Control Process" (GDE-6212) mitigation guidance will be incorporated into applicable work controls, JSAs, and RWPs.

4.1 Voluntary Protection Program and Integrated Safety Management System

Project operations will incorporate Voluntary Protection Program (VPP) and ISMS criteria, principles, and concepts to identify and mitigate hazards, thereby preventing accidents. All management and workers are responsible for implementing safety policies and programs and for maintaining a safe and healthful work environment. Personnel will take a proactive role in preventing accidents, ensuring safe working conditions for themselves and fellow personnel, and complying with all work control documents, procedures, and permits.

The **ISMS** is focused on the **system** side of conducting operations, and **VPP** concentrates on the **people** aspect of conducting work. Both programs define work scope, identify and analyze hazards, and mitigate the hazards. The INEEL and its subcontractors participate in VPP and ISMS. This Accelerated Retrieval Project HASP includes all elements of both systems. The five key elements of VPP and ISMS and their corresponding HASP sections are as shown in Table 4-1.

Table 4-1. Five key elements of the Voluntary Protection Program and Integrated Safety Management System and corresponding sections of the health and safety plan.

Voluntary Protection Program	Integrated Safety Management System	Project Health and Safety Plan Section
Work site analysis	Define work scope	Section 1
	Analyze hazards	Sections 2, 3, 5, and 8
Hazard prevention and control	Develop and implement controls	Sections 2, 3, 4, 5, 7, 10, and 11
Safety and health training	Perform within work controls	Section 6
Employee involvement		Sections 2, 3, and 4
Management leadership	Provide feedback and improvement	Sections 6 and 9

4.2 General Safe Work Practices

The following general safe work practices are mandatory for all personnel to reduce the likelihood of accidents, injuries, and exposures. In addition, all visitors permitted to enter Accelerated Retrieval Project operational work areas must follow these requirements. Failure to follow these practices may result in permanent removal from the Accelerated Retrieval Project and other disciplinary actions. The Accelerated Retrieval Project shift supervisor in conjunction with HSO and assigned health and safety and RadCon personnel will be responsible for ensuring the following safe work practices are adhered to during project construction and operations:

- Limit access to project construction and operations areas to authorized personnel only.
- Personnel must be aware of and comply with all safety signs, tags, barriers, and color.
- Be familiar with the physical characteristics of the Accelerated Retrieval Project facilities and requirements, including, but not limited to, the following:
  - Layout of the Accelerated Retrieval Project controlled areas and egress routes.
  - Project waste types, labeling, and storage requirements.
  - Facility safety-significant structures, systems, and components; technical safety requirements; and limiting conditions of operation.
  - Facility and RWMC warning devices and alarms.
  - Communications with the RWMC shift supervisors.
  - Major SDA roads and means of access to and from the Accelerated Retrieval Project.
  - Location of facility emergency response equipment and first-aid supplies.
- Be alert for dangerous situations (e.g., facility alarms, spills, accidents, and injuries) and report dangerous situations and near misses to the shift supervisor. The shift supervisor will make required notification in accordance with Section 10.

- Provide adequate information to the oncoming shift personnel, including equipment and system status and inspection logs, and communicate all systems, monitors, and safety components that are nonoperational and ensure they are tagged as to their appropriate status (e.g., "Out of Service" or "Do Not Use").

- Plan and review all operational tasks before initiating the activity. Verify all work control documents (e.g., the RWP, JSA, TPR, or work order) are current and correct for the activity. A prejob briefing is required to be conducted for all activities in accordance with "Performing Pre-Job Briefings and Documenting Feedback" (MCP-3003).

- Conduct all construction and operations in accordance with the applicable TPR or work order. All activities will be conducted as stated in the applicable work control document including hold points and requirements for initials upon completion of certain steps (Use Type 1 TPR only) or work orders. Use Type 2 TPRs will be followed in a step-by-step sequence.

Note: It is the responsibility of all personnel to identify, understand, and follow the appropriate work controls for their operational activities.

- All personnel shall have the authority to initiate STOP WORK actions in accordance with "Stop Work Authority" (MCP-553) or "Stop Work Authority" (PRD-1004) as appropriate.

- Personnel shall be familiar with tools and equipment for which they are responsible to operate including operating limitations, maintenance, inspection, and manufacturer's operating instructions requirements. Tools and equipment shall only be used for their intended use.

- Understand the PPE requirements for all tasks as stated on the applicable JSA or work order. This includes the proper use and limitation of all PPE. If questions arise about PPE, contact the assigned IH, safety professional, or RCT as applicable.

- Personnel must wear all required dosimetry as stated on the RWP. This includes any supplemental dosimetry (e.g., electronic dosimeters and albedo dosimeters). Respond to all radiological alarms including, but not limited to, constant air monitors, criticality system, radiation, and PCM alarms.

- Avoid direct contact with waste material or containers. Personnel shall not walk through spills or other areas of contamination and shall avoid kneeling, leaning, or sitting on equipment or surfaces that may be contaminated.

- Personnel shall not eat, drink, chew gum or tobacco, smoke, apply cosmetics or sunscreen, or perform any other practice that increases the probability of hand-to-mouth transfer and ingestion of materials in project operations areas, except within designated administrative break areas and only after having completed required contamination surveys. Drinking water may be permitted in areas specified and controlled in accordance with RadCon and IH approval.

- Practice good housekeeping at all times. Turn in or place tools in the designated storage location after use. Put waste materials in the appropriate waste container or receptacle. If there is a question as to where to dispose of a waste article, personnel should ask the supervisor or the shift supervisor.

4.3 Subcontractor Responsibilities

Where subcontractors are used to support project construction or operations, subcontractors are responsible for meeting all applicable INEEL MCP, program requirements document, VPP, and ISMS flow-down requirements, such as those listed on "Subcontractor Requirements Manual (SRM) Applicability" (Form 540.10), *Subcontractor Requirements Manual* (TOC-59), and contract general and special conditions. Additionally, subcontractors are expected to take a proactive role in hazard identification and mitigation while conducting operational support tasks. Subcontractors will report unmitigated hazards to the Accelerated Retrieval Project subcontractor technical representative (STR) or RWMC shift supervisor after taking protective actions (within the documented work controls) and emergency protective actions.

4.4 Radiological and Chemical Exposure Prevention

Where entry into contaminated areas is required, chemical, radiological, and physical hazards will be mitigated through the use of engineering controls, work procedures and hold points, area and personnel monitoring, and PPE where possible or to minimize exposure potential. All personnel are responsible for understanding the hazard identification and mitigation measures necessary to prevent or reduce exposures. This section presents radiological and chemical exposure prevention strategies for use where engineering controls are not feasible and as good work practices.

4.4.1 Radiological Exposure Prevention—As Low as Reasonably Achievable Principles

The radiation exposure of personnel will be controlled such that exposures are well below regulatory limits established in "Occupational Radiation Protection" (10 CFR 835) and that no radiation exposure occurs without commensurate benefit. All personnel have the responsibility for following ALARA principles and practices.

Note: Unplanned and preventable exposures are considered unacceptable.

The Accelerated Retrieval Project shall establish work controls that will ensure that personnel are adequately protected from known sources of radiation in project areas. The issuance of RWPs, establishment and posting of radiological controlled areas, and review of activities by the RWMC ALARA committee will form the basis for controlling exposure to ionizing radiation during project construction and operations. Personnel working at the Accelerated Retrieval Project must strive to keep both external and internal radiation doses ALARA by adopting the practices in the following sections.

4.4.1.1 External Radiation Dose Reduction. The RWPs written for project construction and operations will define radiological hold points, required dosimetry, RCT coverage, radiological controlled areas, and radiological limiting conditions in accordance with "Radiological Work Permit" (MCP-7). Radiological Control personnel will participate in the prejob briefing required by "Performing Pre-Job Briefings and Documenting Feedback" (MCP-3003) to ensure all personnel understand the dose-rate limits and limiting conditions on the RWP. All personnel will be required to read and acknowledge the RWP requirements before being allowed to sign the RWP (or scan the RWP bar code in RCIMS) and obtain electronic dosimetry.

Basic ALARA protective measures used to reduce external doses include (1) minimizing time in radiation areas, (2) maximizing the distance from known sources of radiation, and (3) using shielding whenever possible. Specific examples of these methods are provided in the following subsections.

4.4.1.1.1 Methods for Minimizing Time in Radiation Areas—Personnel will incorporate the following methods for minimizing time in radiation areas:

- Preplan all work activities and conduct dry runs where necessary to validate procedures and equipment functional testing
- Plan and discuss the tasks before entering a radiation area (including having all equipment and tools prepared)
- Perform as much work as possible outside radiation areas and take advantage of lower dose-rate areas (as shown on the radiological survey maps)
- Take the most direct route to the task area and work efficiently
- Hold technical discussions outside radiation areas if problems occur in the radiation areas, and then return to the work area to complete the task
- Know stay time and use appropriate signal and communication method to inform others in the area when the stay time is up, if stay times are required
- Respond to electronic dosimetry alarms by notifying others in the area and the RCT, and exit the radiation area through the designated entry and exit point
- Know individual current dose and dose limit.

Note: If RCIMS indicates an individual is approaching or has exceeded the dose limit, the RCT should be notified immediately and the worker should not proceed into the radiation work area.

4.4.1.1.2 Methods for Maximizing Distance from Radiation Sources— Personnel will incorporate the following methods for maximizing the distance from radiation sources:

- Use remote-operated equipment or controls where available
- Stay as far away from the source of radiation as possible (extremely important for point sources where, in general, if the distance between the source is doubled, the dose rate falls to one-fourth of the original dose rate)
- Become familiar with the radiological survey map for the project area where work will be performed, as well as high and low dose-rate locations, and take advantage of low dose-rate areas.

4.4.1.1.3 Proper Use of Shielding—Personnel will incorporate the following methods for the proper use of shielding as a protective measure used to reduce external radiation doses:

- Know what shielding is required and how it is to be used for each radiation source
- Take advantage of the equipment and enclosures for shielding from radiation sources
- Verify interlocks are functional and use shielding when operating drum assay equipment
- Wear safety glasses to protect eyes from beta radiation.

4.4.1.2 *Internal Radiation Dose Reduction.*

The most significant internal radiation dose potential exists during entry into the Retrieval Enclosure during excavation and waste processing. An internal dose is a result of radioactive material being taken into the body. Radioactive material can enter the body through inhalation, ingestion, absorption through wounds, or injection from a puncture wound. Reducing the potential for radioactive material to enter the body is critical to avoid an internal dose. The following are methods to minimize the hazard of an internal radiation dose:

- Preplan all work activities and conduct dry runs where necessary to validate procedures and equipment functional testing
- Verify samplers are functional before entry into contamination or airborne radioactivity areas
- Review the RadCon survey map for areas of known contamination and potential high-contamination sources and minimize or avoid activities in those areas (where possible)
- Wear protective clothing and respiratory protection as identified on the RWP, perform all respirator leak checks, and inspect all PPE before entering contaminated areas or areas with airborne radioactivity
- When inside contaminated areas, do not touch your face (adjust glasses or PPE) or other exposed skin
- Respond to all alarms or other indications of increased contamination levels (RCT directions)
- When exiting contaminated areas, follow all posted instructions and remove PPE in the order prescribed (if questions arise, consult RadCon personnel)
- Conduct whole-body personnel survey when exiting the contaminated area, then proceed directly to the PCM
- Report all wounds or cuts (including scratches and scrapes) before entering radiologically contaminated areas
- Wash hands and face before eating, drinking, smoking, or engaging in other activities that may provide a pathway for contaminants.

Monitoring for radiation and contamination during project tasks will be conducted in accordance with the RWP, "Radiological Control Manual" (PRD-183), *Radiation Protection Procedures* (Manual 15B), and *Radiological Control Procedures* (Manual 15C) and as deemed appropriate by RadCon personnel.

4.4.2 Chemical and Physical Hazard Exposure Avoidance

The primary potential for exposure to nonradiological contaminants is the same as the radiological sources. Additionally, chemicals (e.g., fuels, lubricants, and cleaners) will be used in support of project construction and operations. A material safety data sheet (MSDS) is required to be available for all chemicals used in accordance with "Hazard Communication" (MCP-2715) for operations and maintenance or "Hazard Communication" (PRD-2101) for construction. All chemicals entering the Accelerated Retrieval Project facility must be entered into and tracked using the INEEL Chemical Management System. The INEEL Chemical Management System is used for maintaining and tracking the inventory of chemical containers, and its basic functionality includes the following:

- Identify container
- Track the location and location changes of a container
- Define the contents of a container at any point in time
- Record distributions into and out of a container
- Record distributions to a waste stream
- Provide a running inventory based on the distributions entered
- Produce regulatory reports from the data entered
- Calculate conversions from one unit of measure to another
- Define container update authorization for a location
- Provide flexibility in how to manage chemicals.

Note: Project waste streams are not considered chemicals for purposes of entry into INEEL Chemical Management System.

Threshold limit values or other occupation exposure limits have been established for numerous chemicals and physical agents (e.g., noise, heat, or cold stress) that may be encountered. These exposure limits provide guidelines in evaluating airborne, skin, and physical agent exposures. The TLVs represent levels and conditions under which it is believed that nearly all workers may be exposed day after day without adverse health effects. The TLV TWA is a TWA concentration for a conventional 8-hour workday and a 40-hour workweek, to which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse health effects. Action limits (instantaneous concentrations for short periods) have been established to further reduce the likelihood of exceeding TLVs or as regulatory triggers for additional medical surveillance and actions. These concentrations for nonradiological COCs are provided in Table 2-3.

4.5 Buddy System

The two-person or buddy system will be used during some Accelerated Retrieval Project operations. The buddy system is most often used during operational activities requiring the use of protective clothing and respiratory protection where heat stress and other hazards may impede a person's ability to self-rescue or in situations that are immediately dangerous to life or health (IDLH). This includes all entries into the Retrieval Enclosure during waste excavation, entry into high-contamination areas, and as determined necessary by the HSO with concurrence of the shift supervisor or STR, assigned IH or safety engineer, and RadCon personnel as appropriate. The buddy system requires each employee to assess and monitor his or her buddy's mental and physical well being during the course of the operation.

A buddy must be able to perform the following activities:

- Provide assistance if required
- Verify the integrity of PPE
- Observe his or her buddy for signs and symptoms of heat stress, cold stress, or contaminant exposure
- Notify other personnel in the area if emergency assistance is needed.